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International Machine Tool Exhibition

Third of Four Special Numbers on

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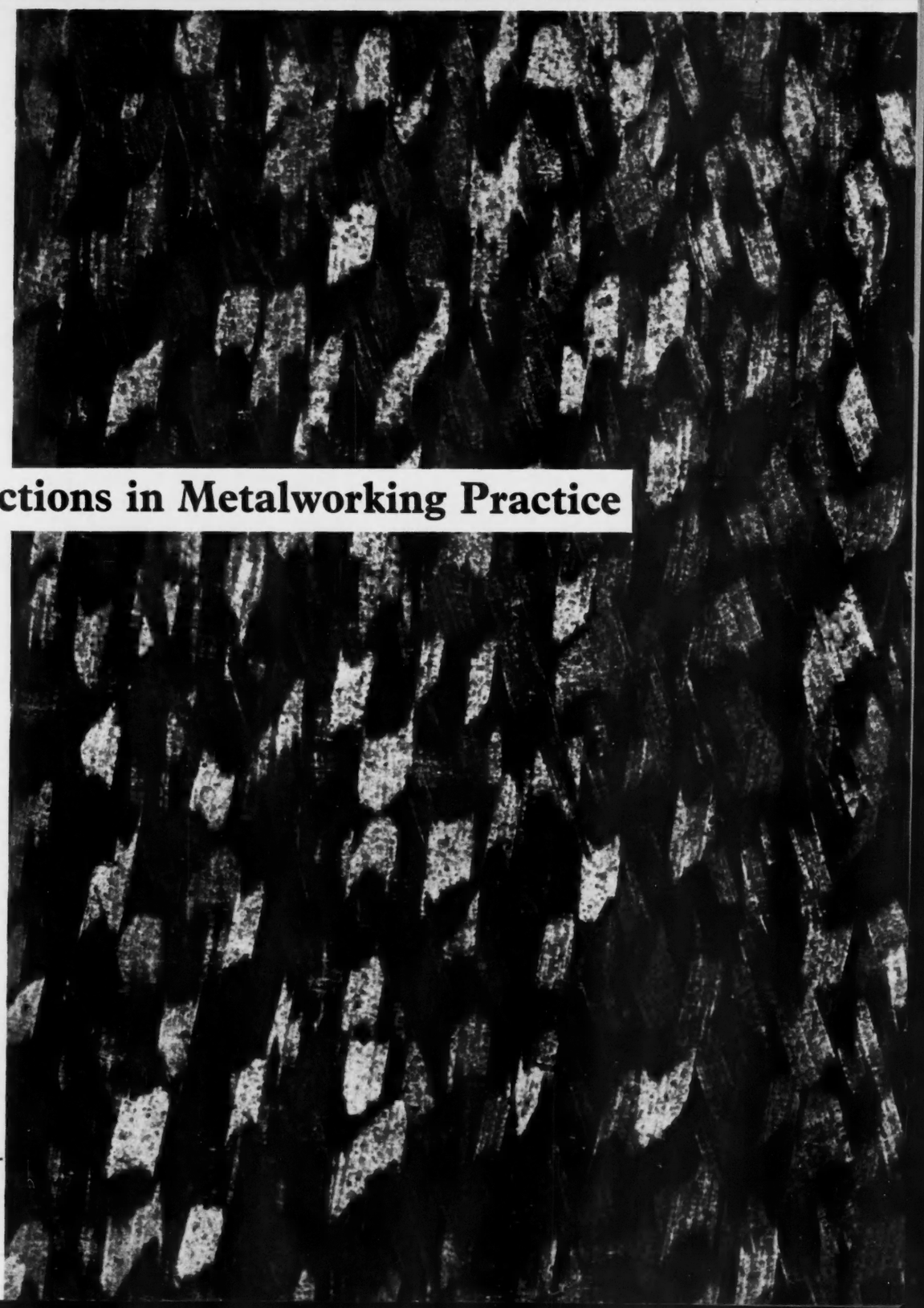

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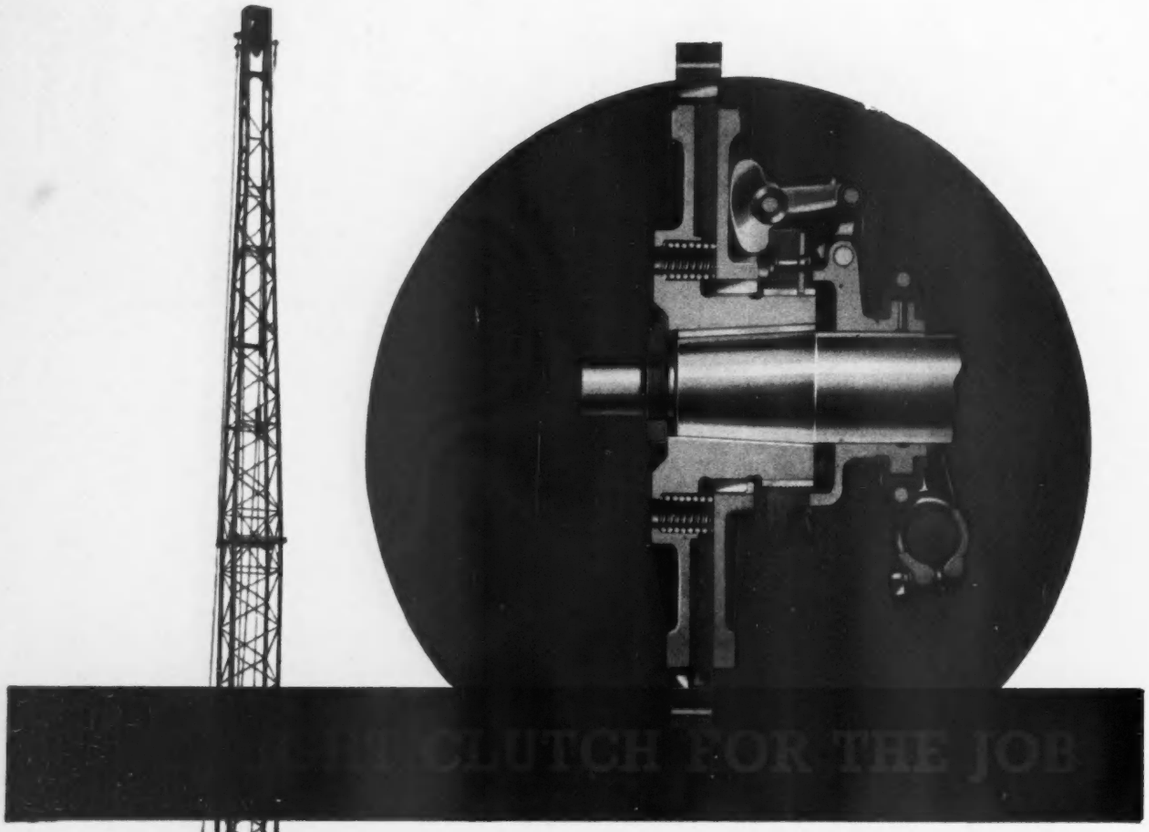

THE CLUTCH FOR THE JOB

The Rockford 11½" single plate over-centre clutch unit is used in the striking side boom equipment (left) made by T. T. Boughton & Sons Ltd., Amersham Common, Buckinghamshire, and installed on a Fowler Challenger 33 Tractor.

The right-hand illustration shows a Caterpillar D.8 Tractor, also fitted with an 11½" Rockford clutch unit and T. T. Boughton side-boom crane attachment.

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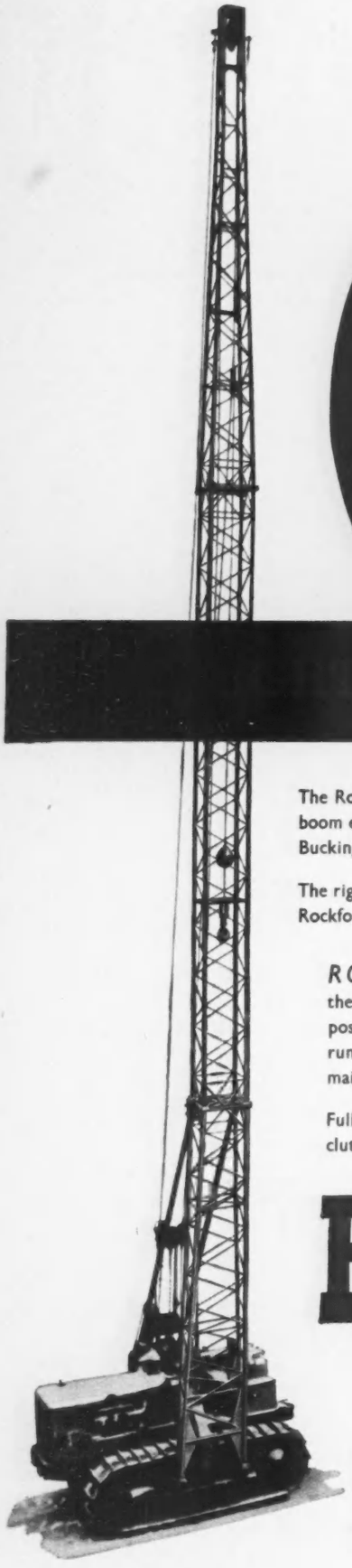

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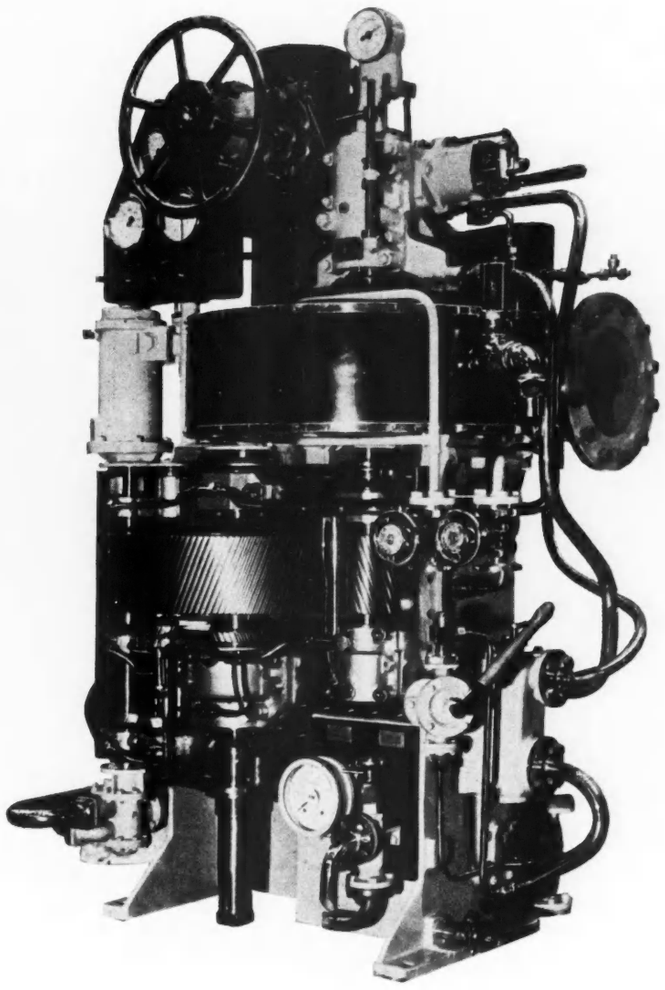

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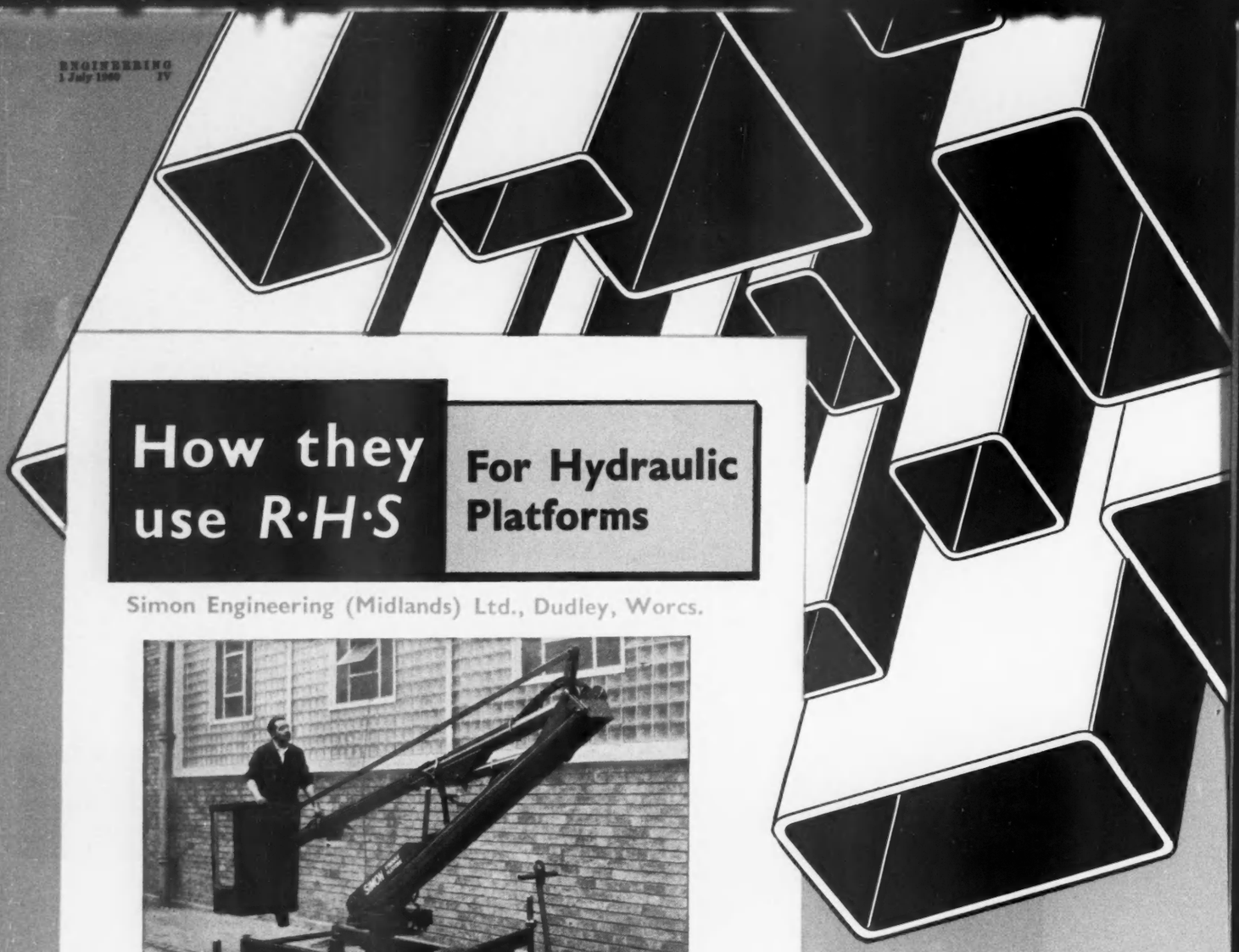
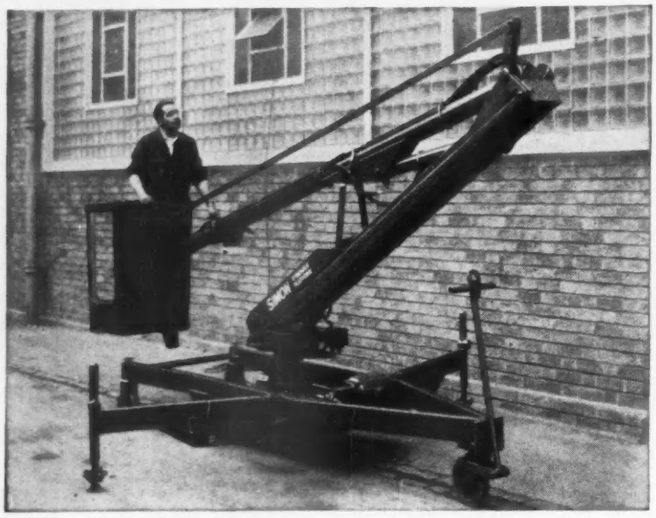


How they use *R·H·S*

For Hydraulic Platforms

Simon Engineering (Midlands) Ltd., Dudley, Worcs.



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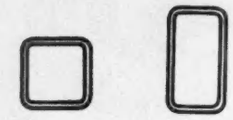

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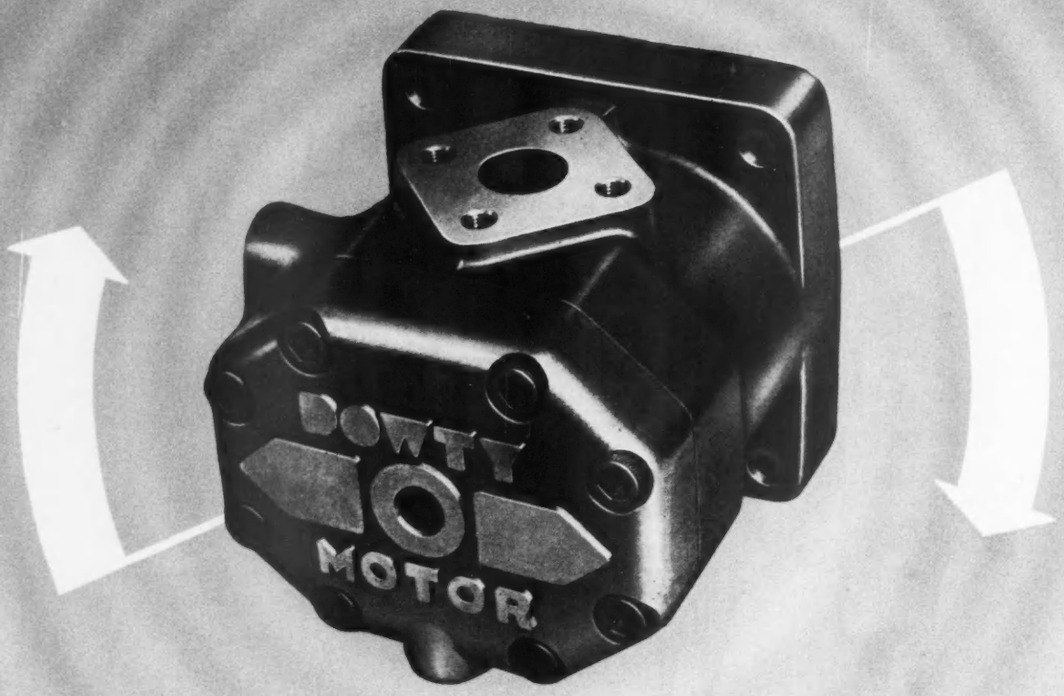

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Cover Picture

Familiar to all engineers will be the hand scraped surface of a machine tool slideway. The cover picture is taken from an enlarged photograph of such a surface. This issue is the third of four special numbers for the London International Machine Tool Exhibition and contains two more articles in the series "New Directions in Metalworking Practice" and, in New Plant and Equipment, there are descriptions of some more of the exhibits.

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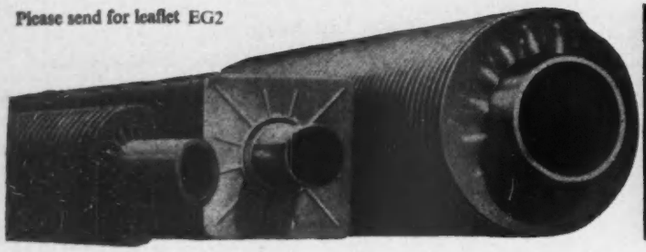

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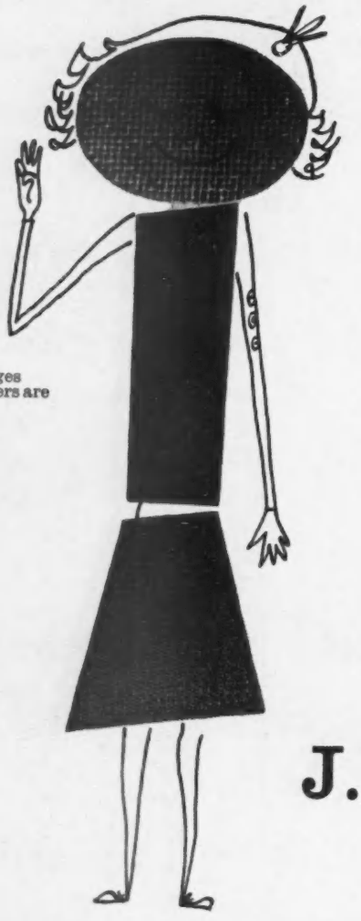

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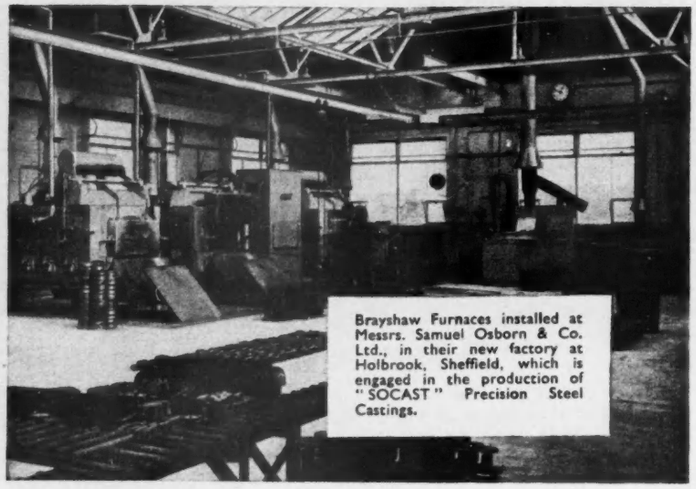

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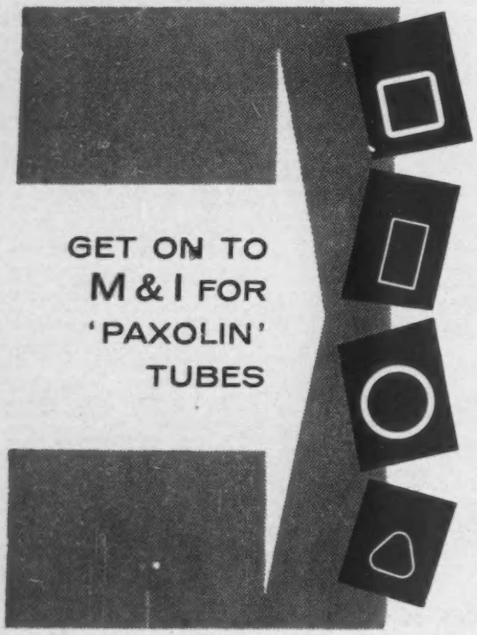

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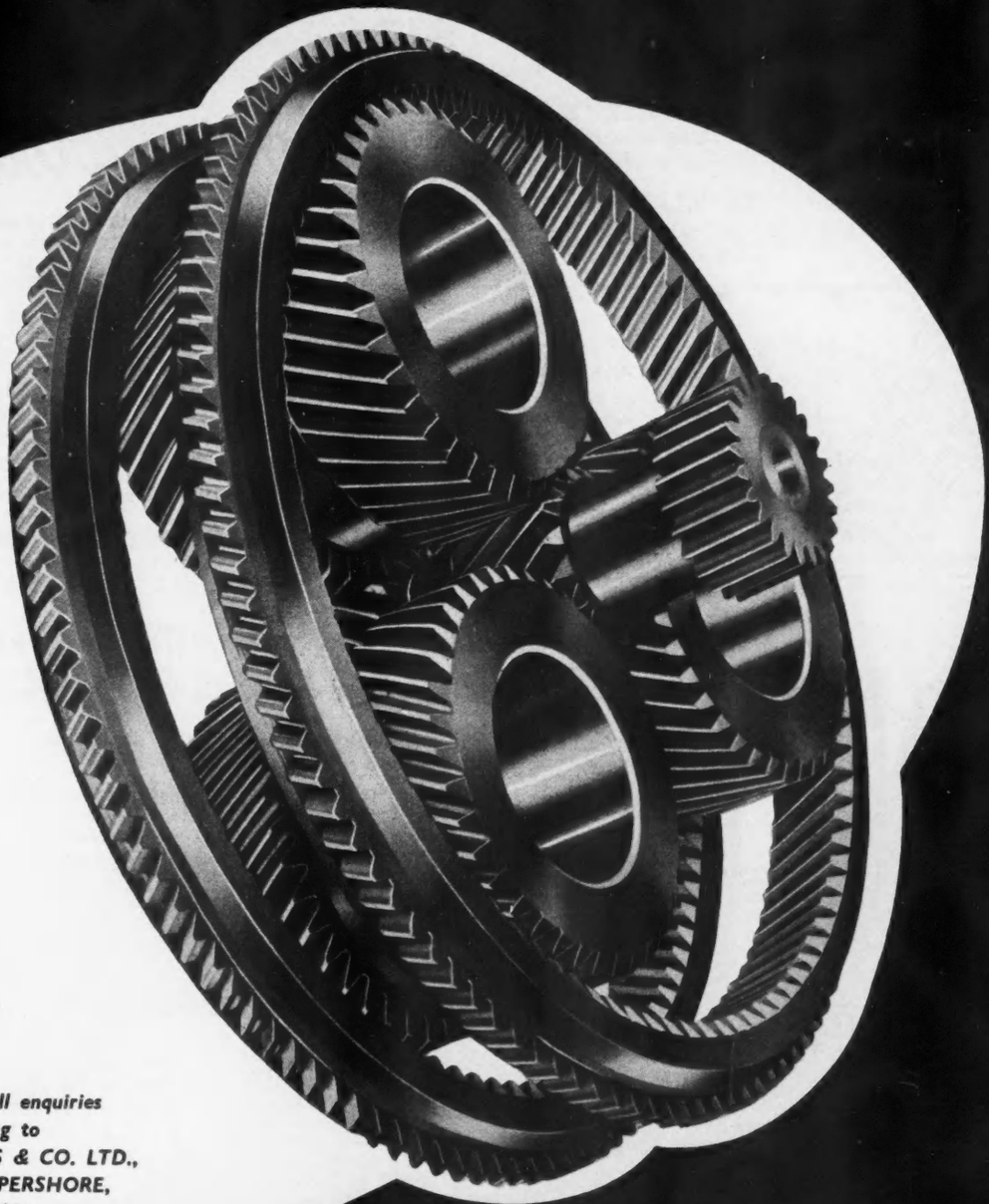

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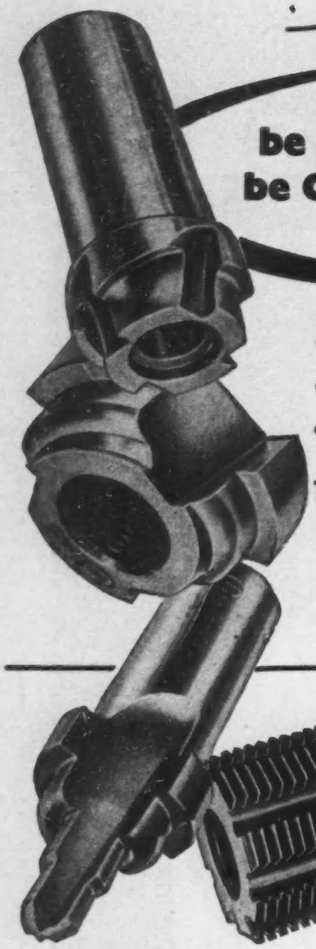

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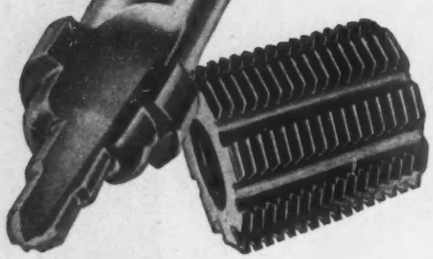

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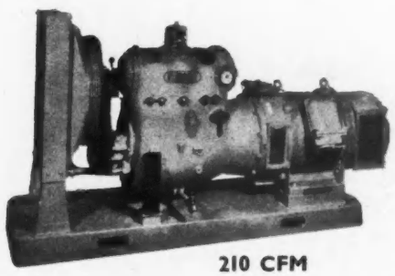

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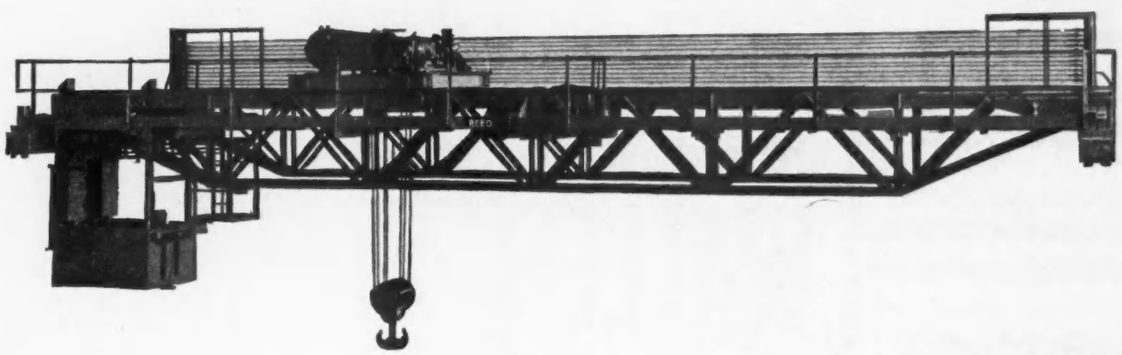

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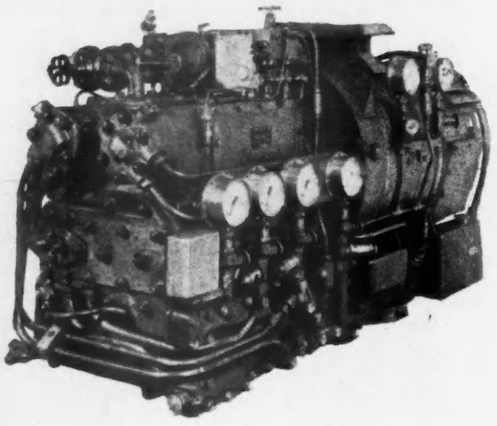

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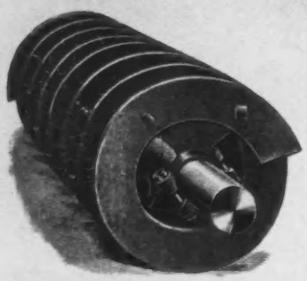

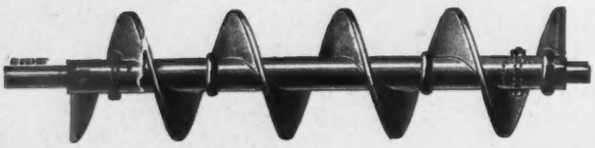

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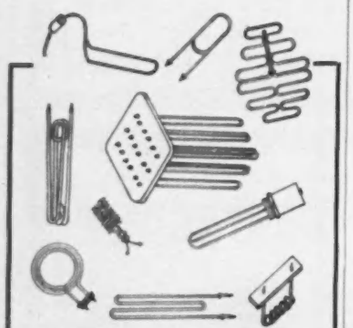

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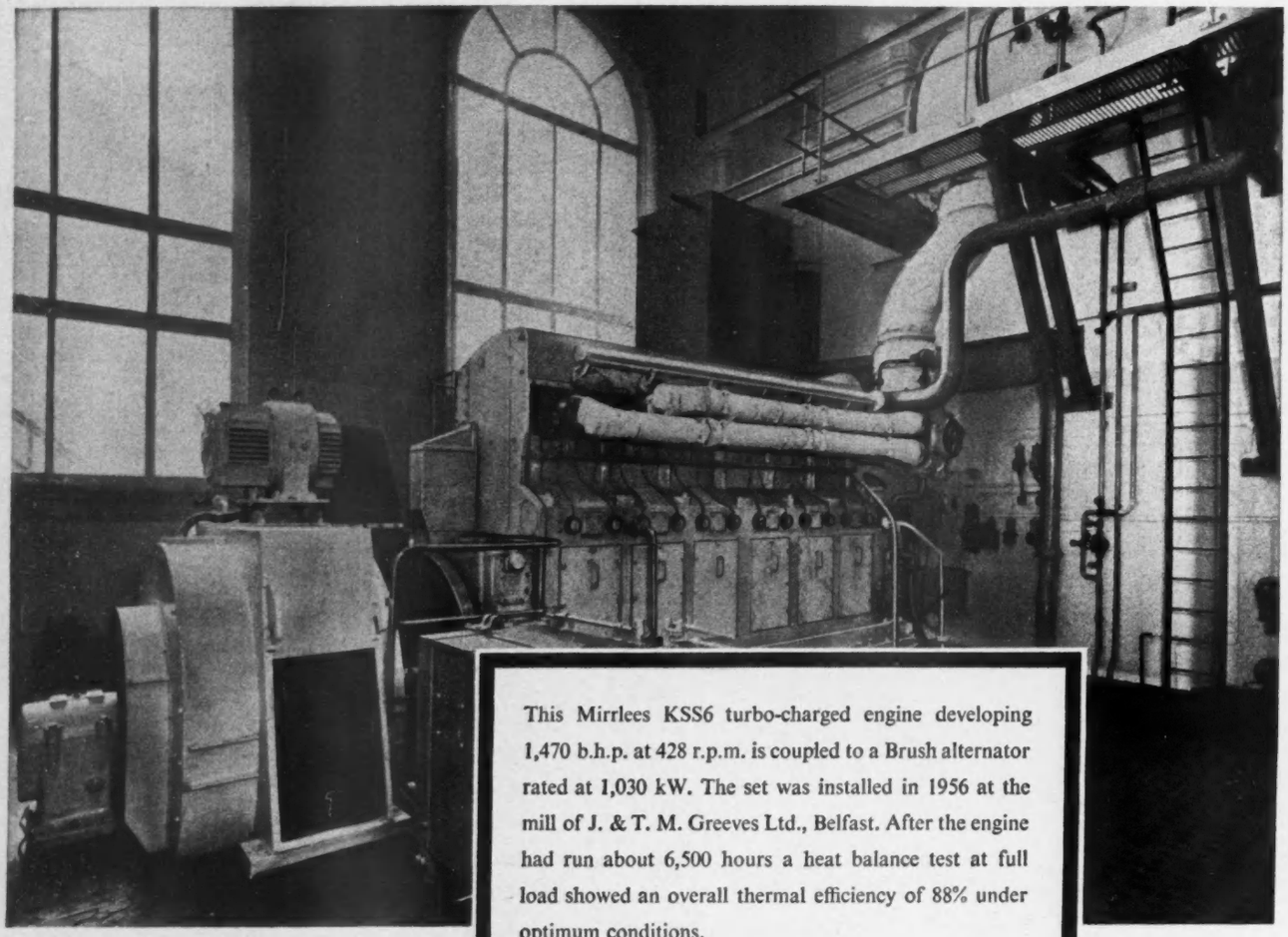
OA/5361



This Mirrlees KSS6 turbo-charged engine developing 1,470 b.h.p. at 428 r.p.m. is coupled to a Brush alternator rated at 1,030 kW. The set was installed in 1956 at the mill of J. & T. M. Greeves Ltd., Belfast. After the engine had run about 6,500 hours a heat balance test at full load showed an overall thermal efficiency of 88% under optimum conditions.

THERMAL EFFICIENCY 88 per cent

achieved by Mirrlees diesel generating plant with "Latent Heat" cooling and exhaust heat recovery

Mirrlees diesels

By fully using the heat in the cooling water and exhaust gases, this plant not only provides electric power for a flax mill at low running cost, but also steam and hot water for process work and space heating. The Mirrlees engine runs on boiler fuel of 3,500-seconds Redwood No. 1 at 100°F. The savings due to the high thermal efficiency at full load and the low-cost fuel enabled the capital expenditure to be recovered in about 24 months.

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IE 30

LIQUID FILTRATION

A 10" bore low ground clearance twin basket filter embodying the special Plenty features described below.

ADVANTAGES of the Plenty Filter:

An exceptionally large filter area is combined with ease of operation, elimination of all tools and avoidance of spillage. Simplex and Duplex types manufactured steam jacketed if required. Plenty filters are made in any size for any job.

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The Burner shown has a maximum output of 12 gallons per hour and requires atomising air at 20" (51 cm) w.g. to 30" (76 cm) w.g. with oil at not less than 5 lbs per sq. in. (0.35 kgs. per sq. cm.) or equivalent head.

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- . . specially designed so that the fuel output and air/oil ratios are under complete control.
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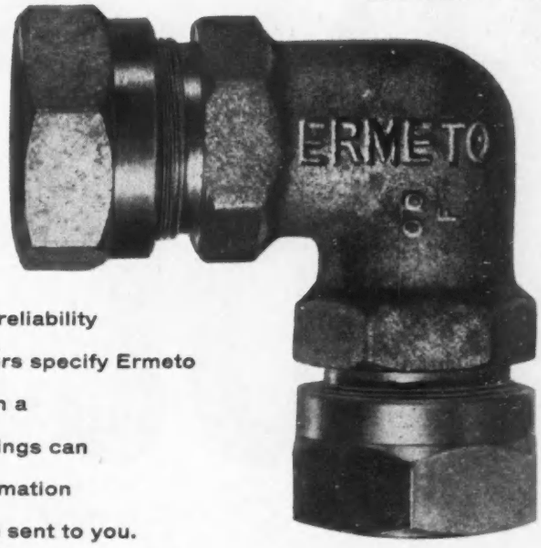
the applications of Ermeto high pressure couplings are practically unlimited



In modern hydraulic-powered equipment, absolute reliability is essential. That is why so many manufacturers specify Ermeto high pressure couplings. These couplings are supplied in a wide range of standard fittings. Non-standard fittings can also be made to meet your specifications. Technical information and our illustrated catalogue will gladly be sent to you.

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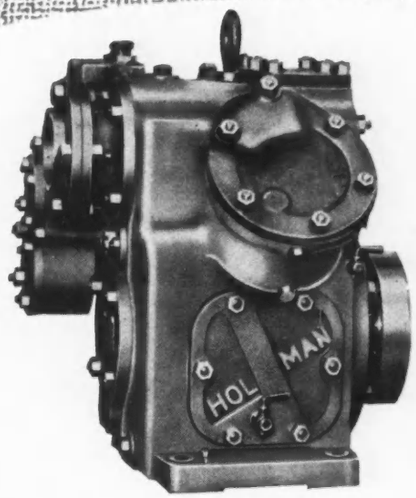

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Choice of reversing
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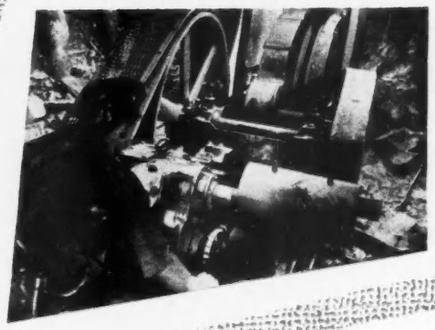

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Light alloy construction.
Vane-type, vibration-free operation.
Remarkable ease of maintenance. Sensitive
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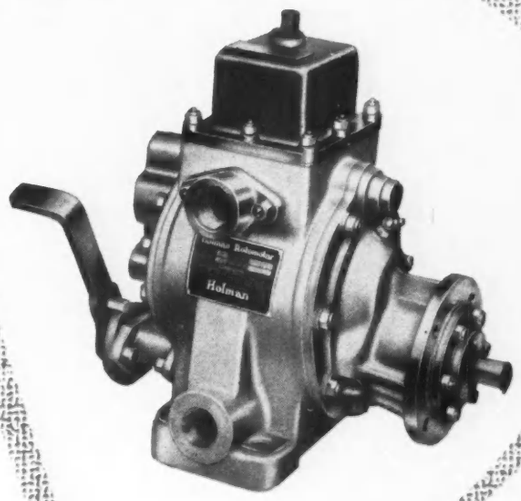

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Holman Vee Engines and Rotomotors

An air motor has to take hard usage—and still keep running smoothly. Air consumption must be low—and stay that way after years of arduous service. Above all, an air motor must be absolutely reliable.

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C

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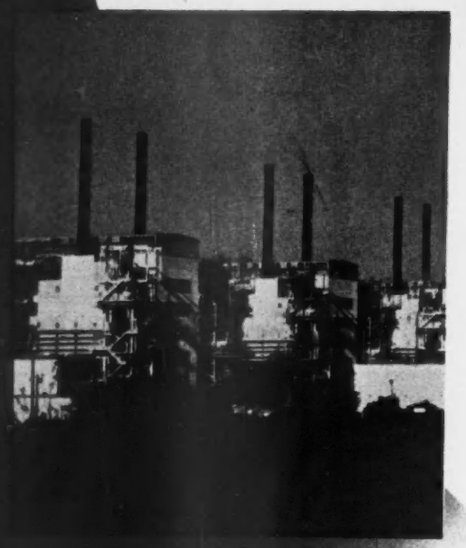

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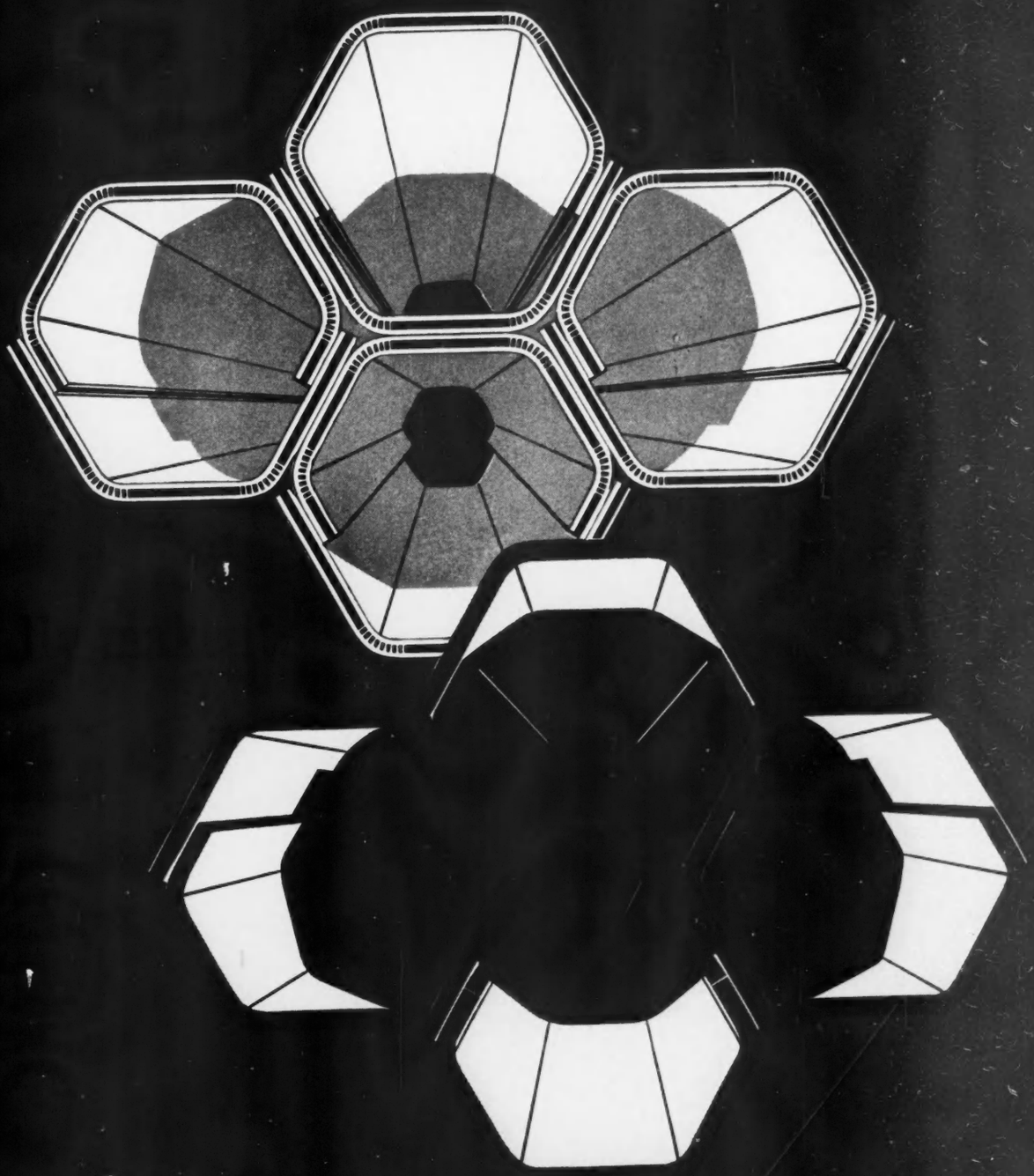

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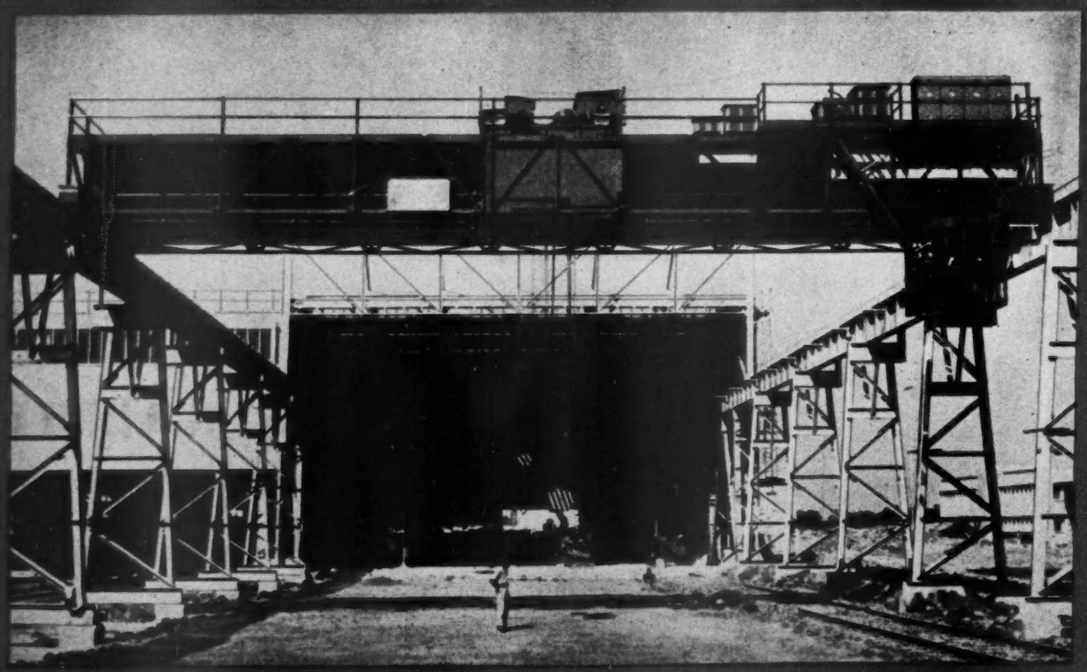

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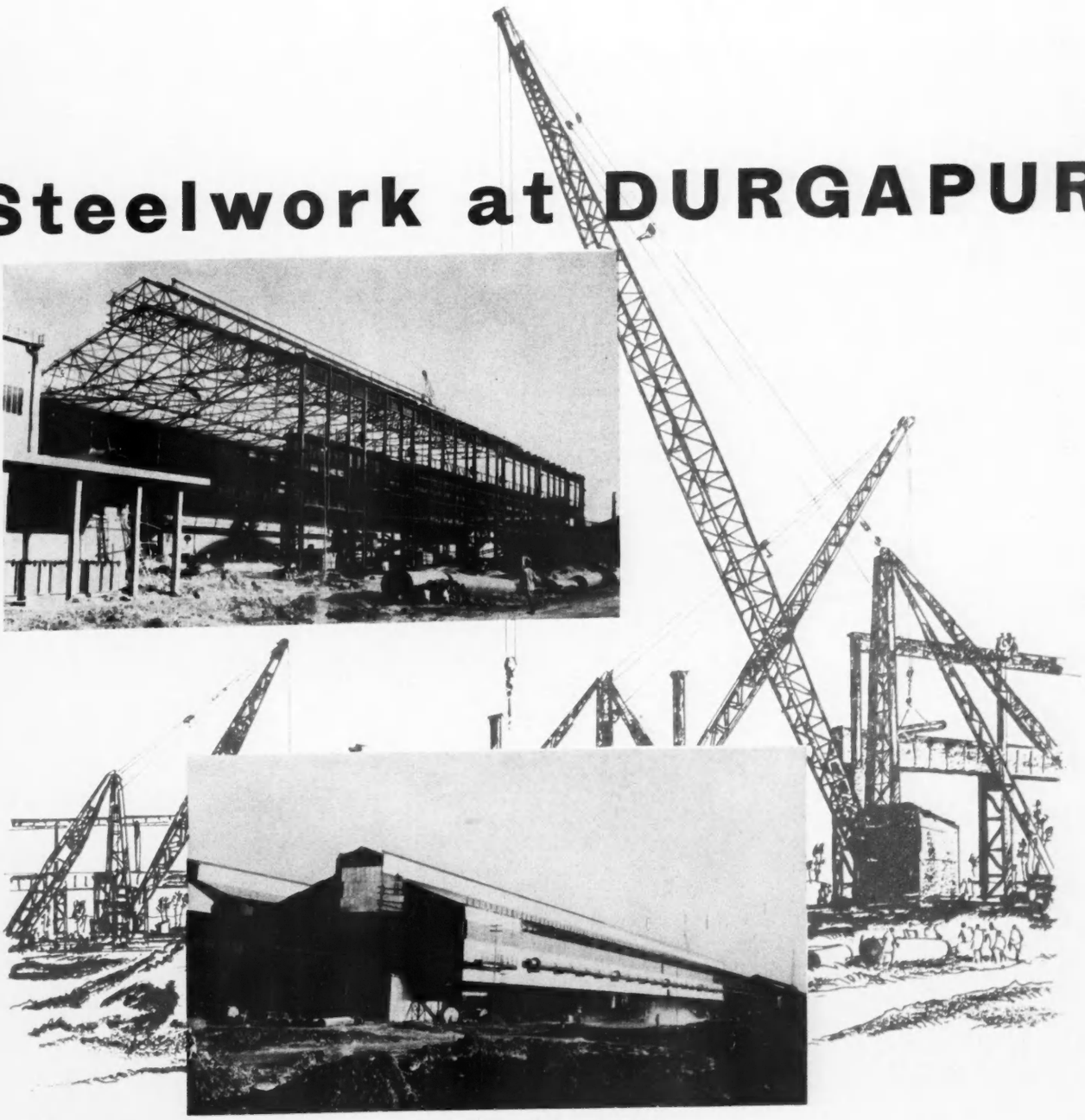
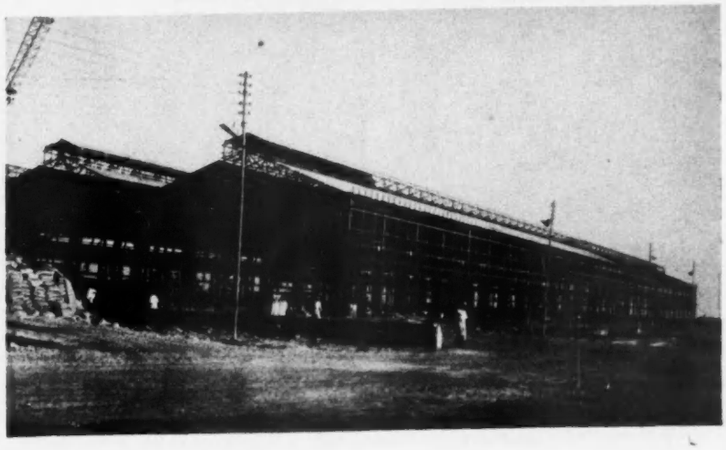
Steelwork at DURGAPUR





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Sturdy and compact, Renold Couplings have for many years proved their value on a wide variety of applications—and they are AVAILABLE FROM STOCK. ***For complete information ask for Catalogue Ref. 116/110***

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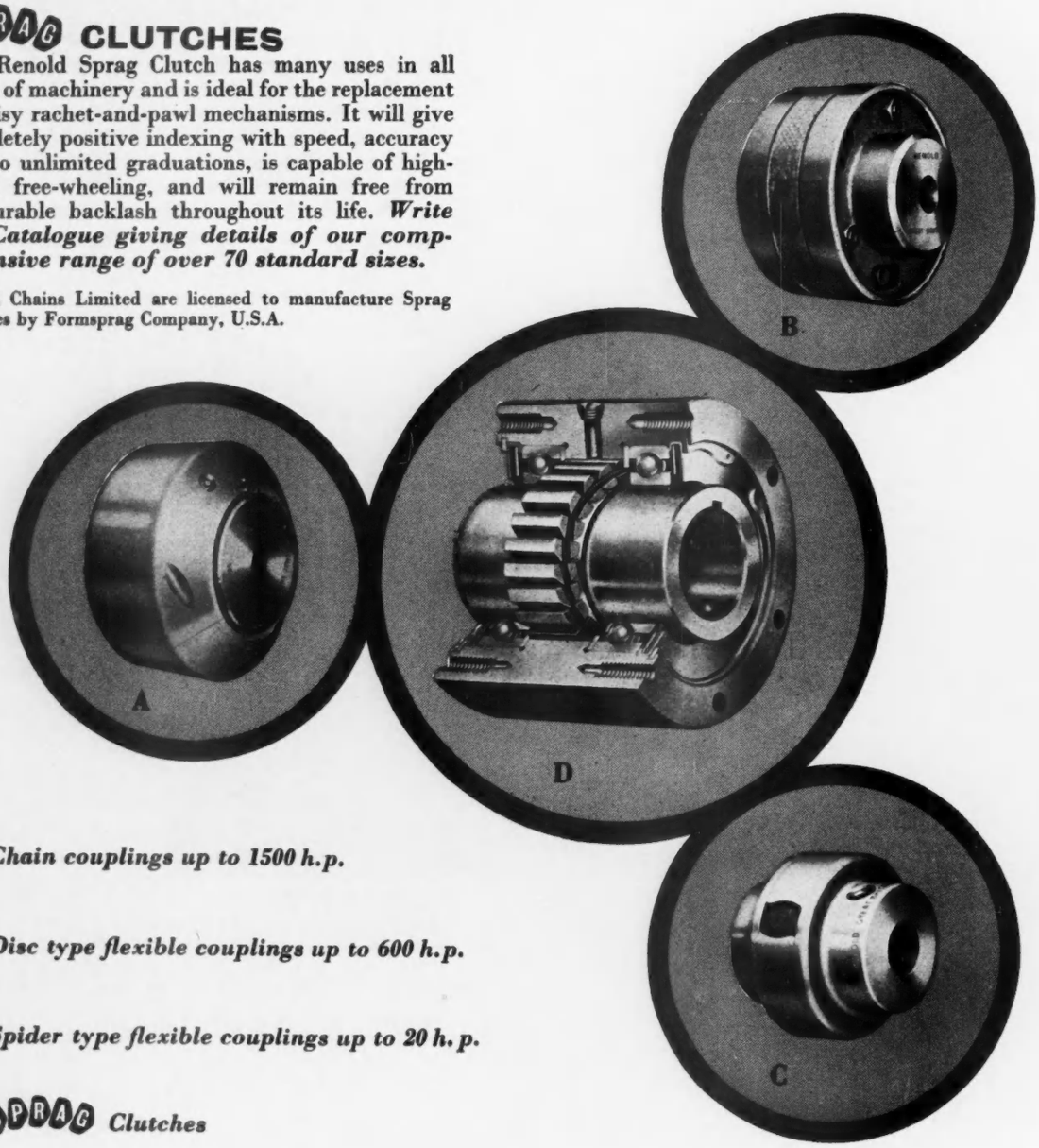
The Renold Sprag Clutch has many uses in all types of machinery and is ideal for the replacement of noisy rachet-and-pawl mechanisms. It will give completely positive indexing with speed, accuracy and to unlimited graduations, is capable of high-speed free-wheeling, and will remain free from measurable backlash throughout its life. ***Write for Catalogue giving details of our comprehensive range of over 70 standard sizes.***

Renold Chains Limited are licensed to manufacture Sprag Clutches by Formsprag Company, U.S.A.



A *Chain couplings up to 1500 h.p.*

B *Disc type flexible couplings up to 600 h.p.*

C *Spider type flexible couplings up to 20 h.p.*

D SPRAG *Clutches*

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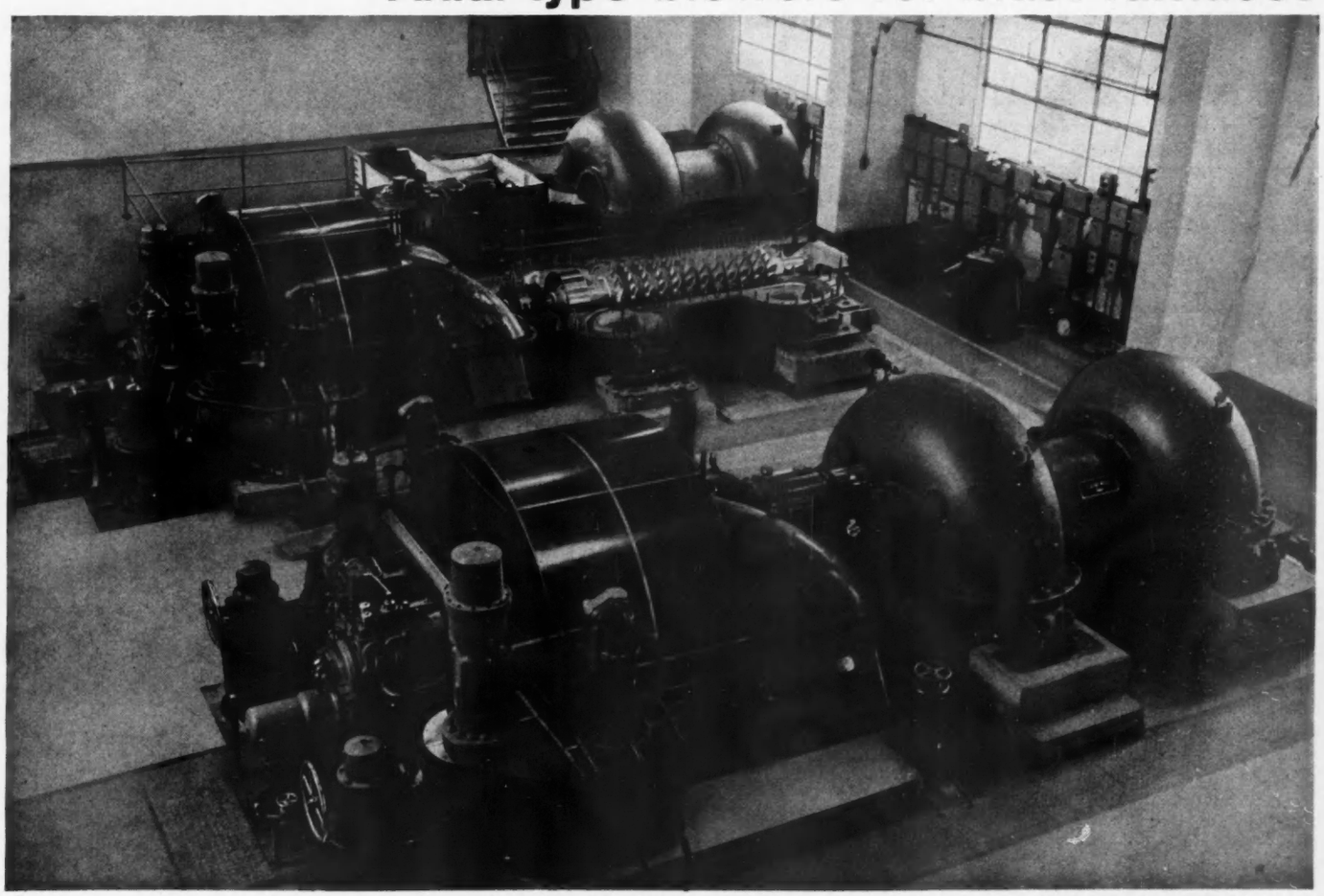

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Simple · Portable · Rapid · Battery Operated · Inexpensive · Standard range: 0.5 to 3 oz/sq. ft.

The technique employed is a Beta backscatter measurement with fully transistorised circuit operating a moving coil meter. It is essentially a practical low-cost instrument for use by those responsible for the condition of galvanised tanks, pylons and similar steel structures.

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"Developed in collaboration with British Insulated Callender's Cables Limited".
"Manufactured and sold under one or more of the U.K. Patent Applications 1928/58, 1927/58, and 7249/58. Corresponding patent applications filed in Canada, France, Germany, Italy, Sweden and U.S.A."

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A New Range of CHEMICAL PUMPS

Here is a range of pumps in Spec. 18/8/3 Stainless Steel and with outputs from 2 to 350 Imp. G.P.M., developing heads from 10 to 210 feet. They have been designed to give maximum interchangeability and flexibility and to be readily available at a competitive price.

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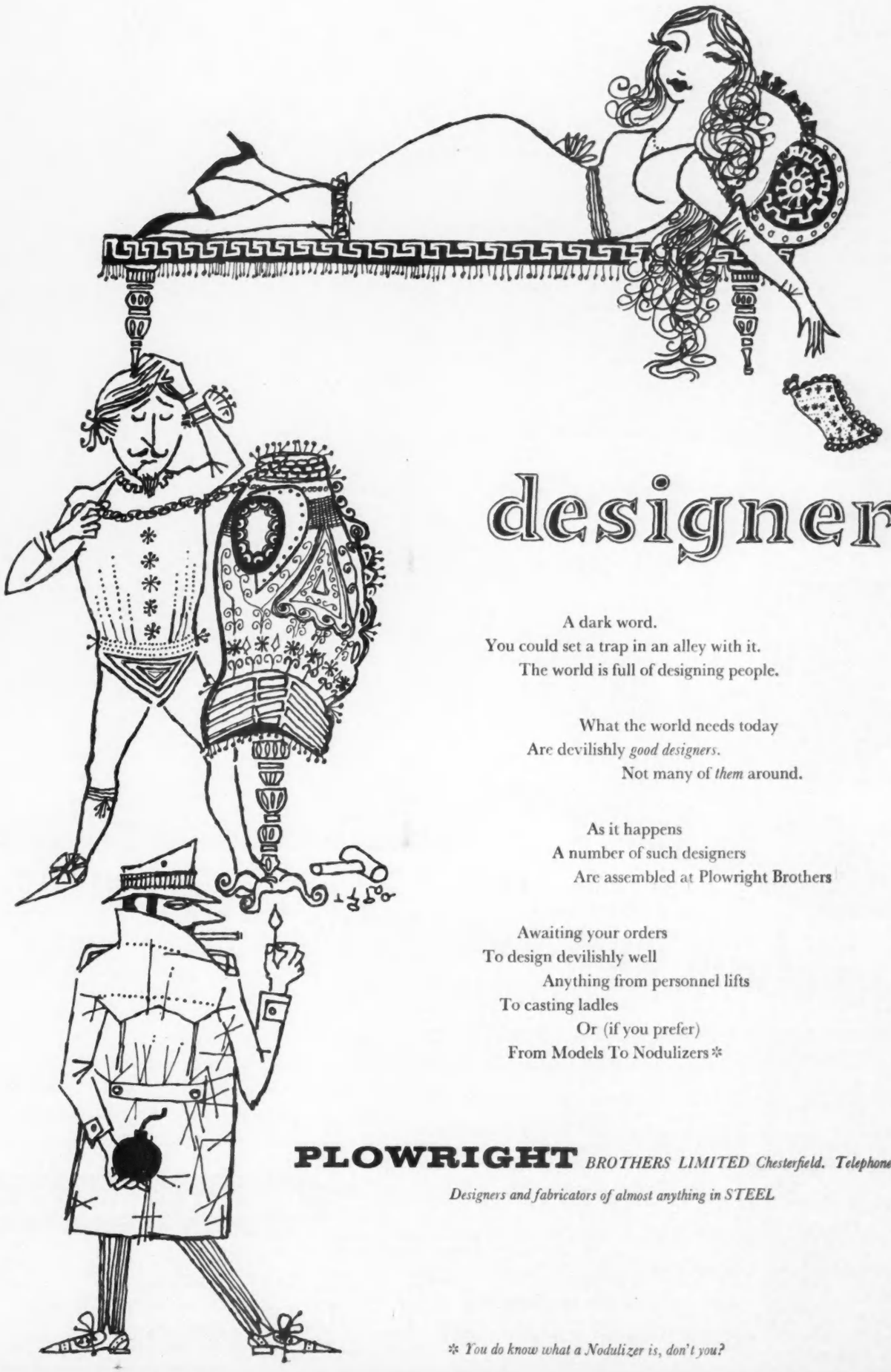

designer!

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You could set a trap in an alley with it.
The world is full of designing people.

What the world needs today
Are devilishly *good designers*.
Not many of *them* around.

As it happens
A number of such designers
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To design devilishly well
Anything from personnel lifts
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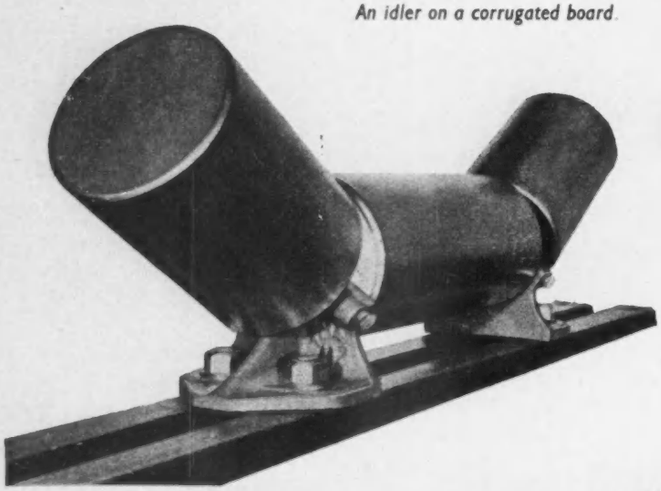
* *You do know what a Nodulizer is, don't you?*

An idler on a corrugated board



WONDERFUL WHAT M&C IDLERS PUT UP WITH

It's not in the instruction book, to run the conveyor under water every time it rains. But it's an odd case. The kind of rain they have in Malaya quickly floods the bottom of this vast tin-mine. They whip the motor off and leave the conveyor to submerge. Then they pump out the water, bring back the motor, and go on loading the tin-bearing silt. They load by hand because down here is too risky for mechanical plant—except the conveyor. A cruel life, but the idlers stand it remarkably. You could hardly ask for harsher proof of how their long-lasting lubrication sees them through. Above or below ground, amid water or dust, in spite of neglect or hard knocks, after years of use or abuse they still spin at a touch. You can save work and worry by changing to M&C idlers.

Illustrated above:
The bottom of the tin-mine, 440 ft. deep.
In the background is the pump-house.
The whole output of the mine is taken up by a system of M&C belt conveyors.

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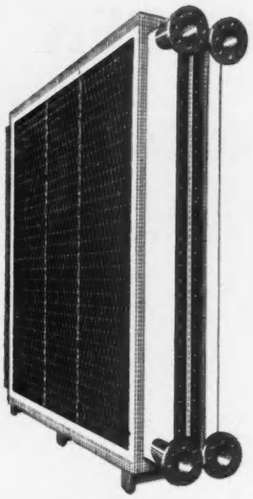

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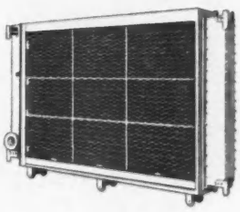

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Body panels, wings, cabs, silencers, petrol tanks, etc.

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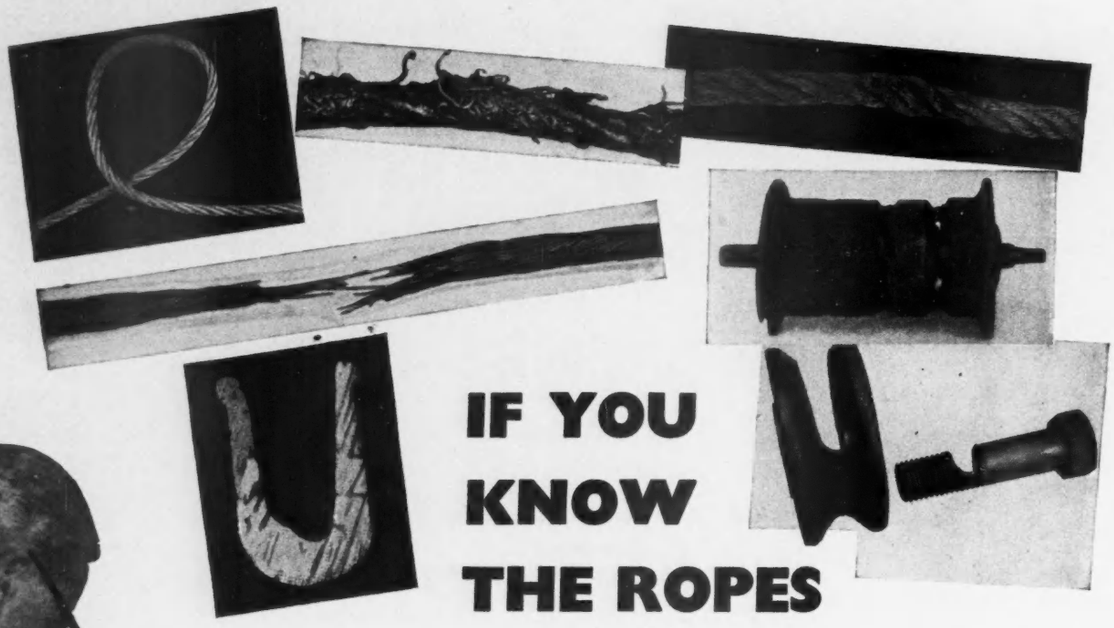
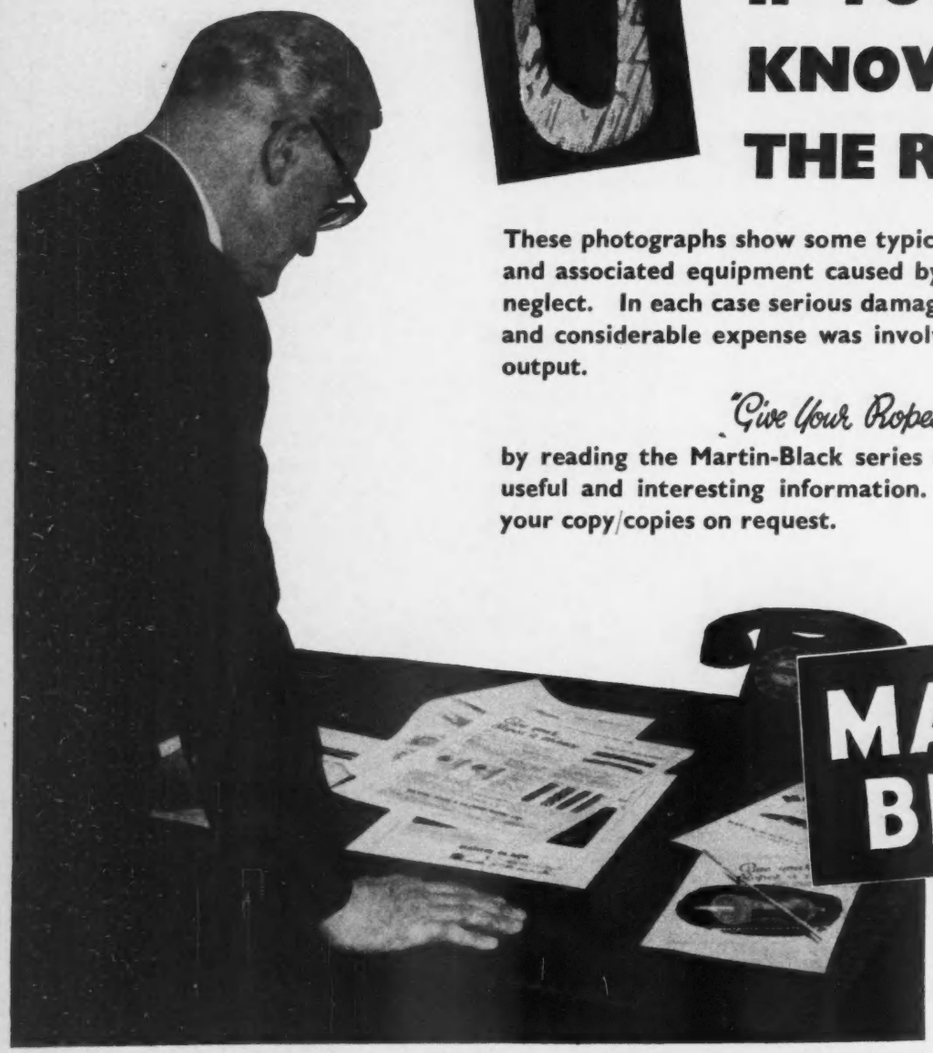


IF YOU KNOW THE ROPES



These photographs show some typical instances of damage to ropes and associated equipment caused by mishandling, wrong fitting or neglect. In each case serious damage was caused to the Wire Rope and considerable expense was involved in replacement and loss of output.

"Give Your Ropes a Chance"

by reading the Martin-Black series of leaflets which contain much useful and interesting information. We will be pleased to send your copy/copies on request.

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WIRE ROPES

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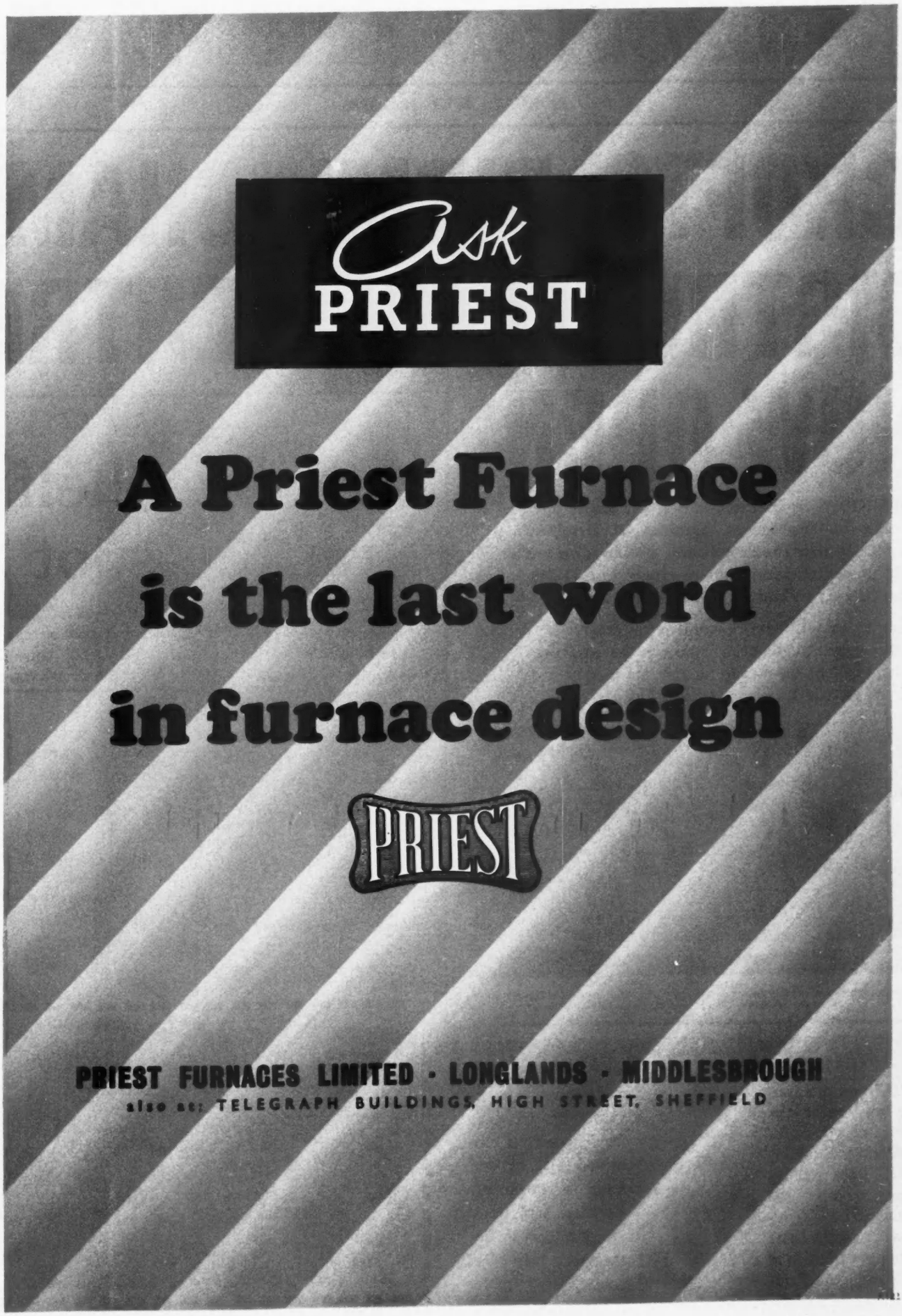
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CROFTS EXPRESS

MONDAY JULY 4th 1960

CROFTS BIRMINGHAM DISTRIBUTION CENTRE NOW OPEN!

BIG NEWS in Birmingham today is the opening by Crofts (Engineers) Limited of Bradford of a completely new showroom and distribution centre for their power transmission products at 253-255, Great Lister Street ('Phone ASTon Cross 4471/2).

Crofts anticipate great interest in this progressive development designed to give their customers the advantage of local stocks, and look forward to meeting old friends made during their 24 years in Birmingham as well as new ones.

Crofts, impressive new distribution centre, stores and showroom for the Birmingham area at the junction of Great Lister Street and Windsor Street.

MR. A. L. DUCKERING

THE new premises are under the control of Mr. A. L. Duckering, Birmingham Area Sales Manager, who has transferred from Crofts, previous Birmingham office at Daimler House, Paradise Street. Interviewed this morning, Mr. Duckering confirmed that he will have a complete technical staff available " to provide on-the-spot help and advice."

NEW STOCK SERVICE

Off-the-shelf on the spot

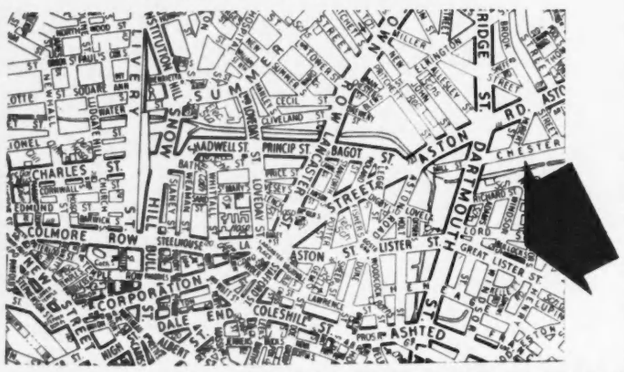
LOCAL ENGINEERS will applaud Crofts of Bradford for the new stock delivery service they now offer in the Birmingham area. Superior service is Crofts' announced aim, and to ensure this, the following large selection of power transmission equipment will be held in stock.

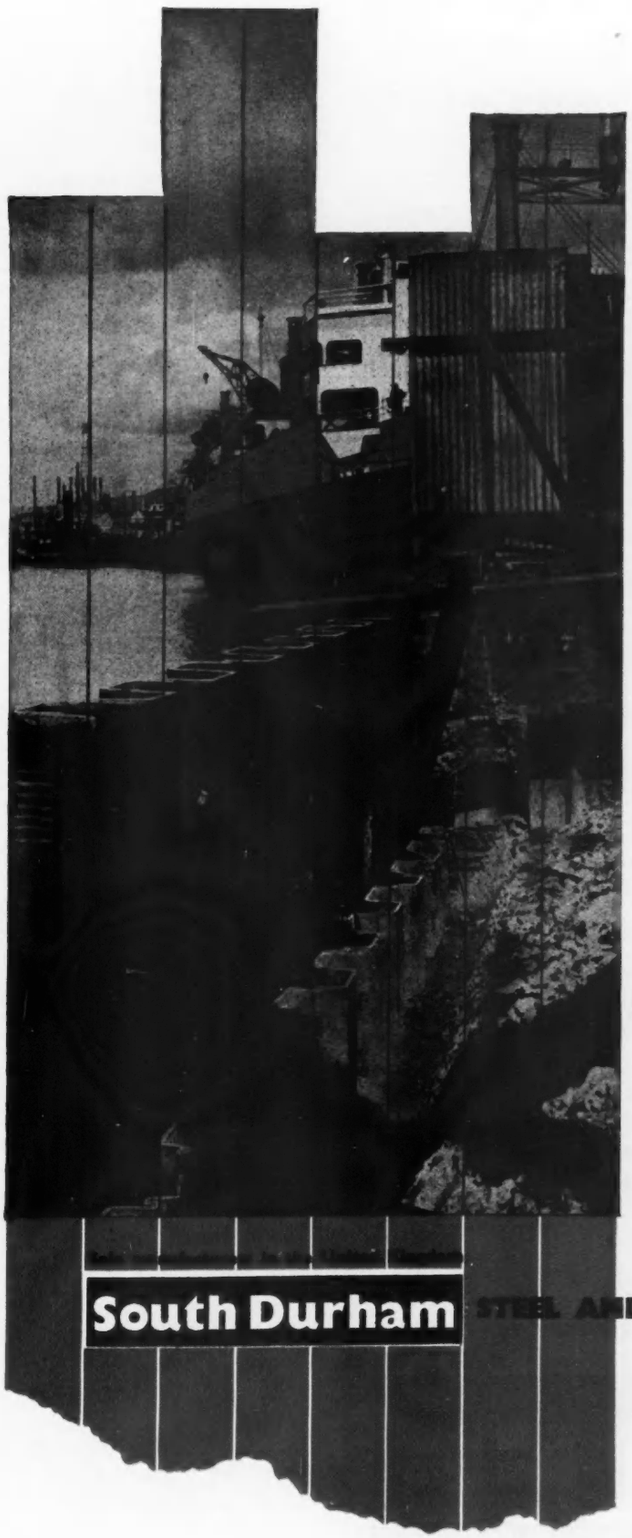
Universal Worm Reduction Gears, Flexible and Rigid Couplings, Shaft-Mounted Gear Units, Collars and Plummer Blocks, 'Radiation' Worm Gears, Light Power Worm Gears, Variable-Speed Pulleys, Slide Rails and Base Plates, V-Rope Pulleys and Drives, Timing Belt Drives, Machine Cut Gears, Taper Flushbushes.

STOP PRESS

Crofts' Birmingham Manager, A. L. Duckering, announced later today extension of worm gear stocks for new office. Crofts' new universal mounting " Par-O-Mount " range will now be represented.

THE ROUTE TO BETTER SERVICE!





For Quays and Jetties you can rely on LARSSEN PILING

Strength, water-tightness and resistance to corrosion make Larssen Piling the ideal Civil Engineering material for the construction of all types of water-frontages. Ease of driving and the economy provided by a very versatile range of sections, are additional advantages.

Larssen Piling, newly-driven, during the extension of the West Jetty at the Scotstoun (Clyde) shipyard of Messrs. Yarrow & Co. Ltd. The Larssen Piling in the foreground, driven about 35 years ago, was found to be in first-class condition and showed no sign of deterioration.

Consulting Engineers: KYLE & FREW
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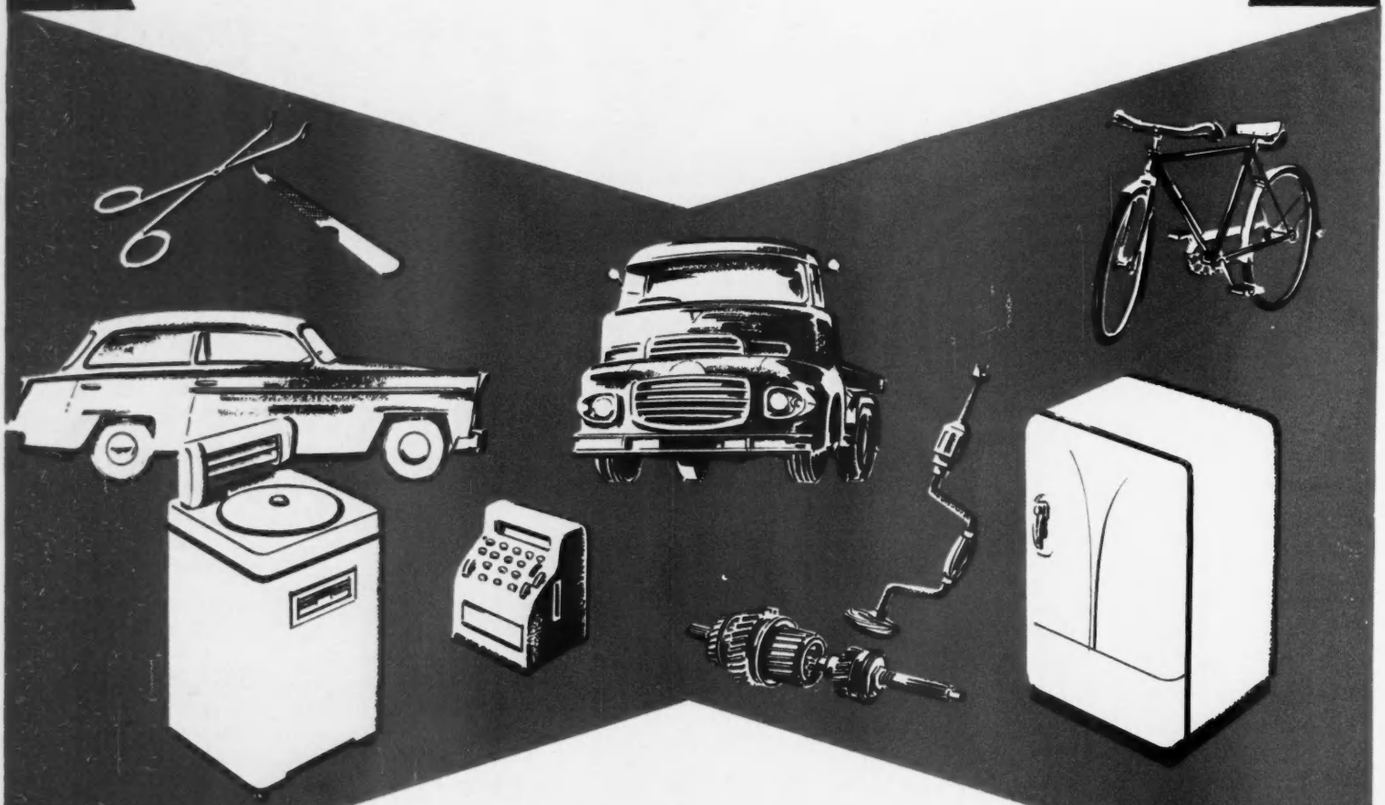

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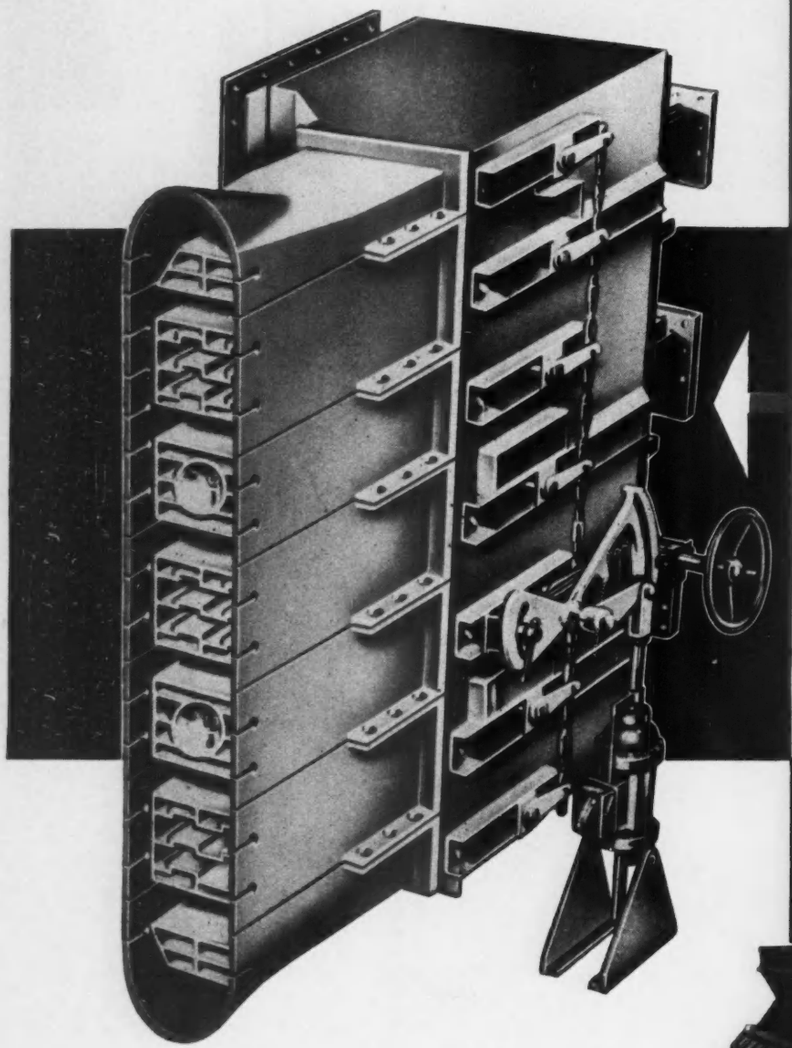

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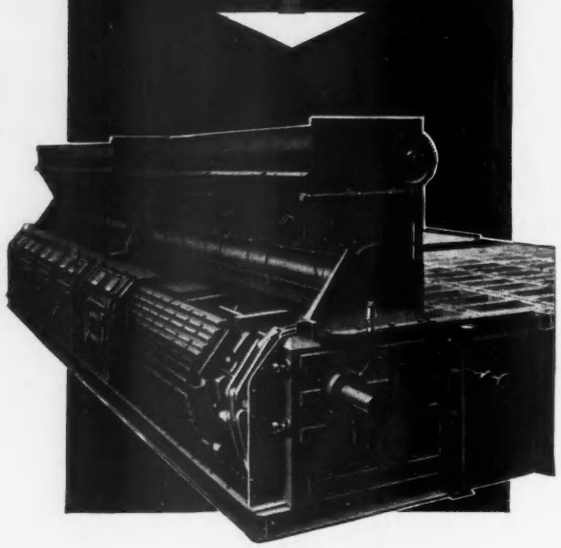

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3000	150	7

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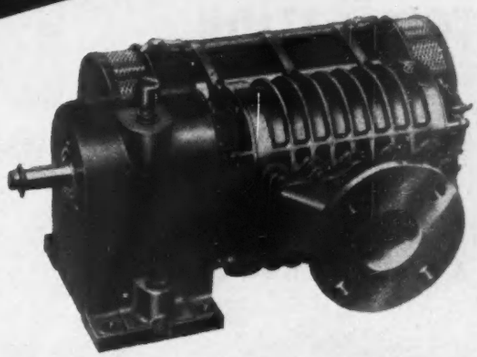
Speed rpm	Airflow cfm	Pressure psi
1500	100	5
2900	200	10



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Speed rpm	Airflow cfm	Pressure psi	
1500	100	5	*
2750	450	10	*
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2750	400	12	†

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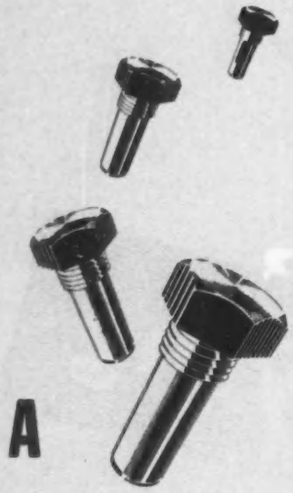

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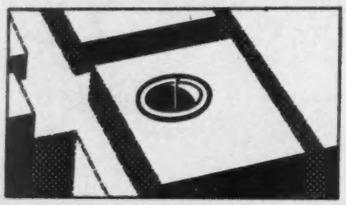

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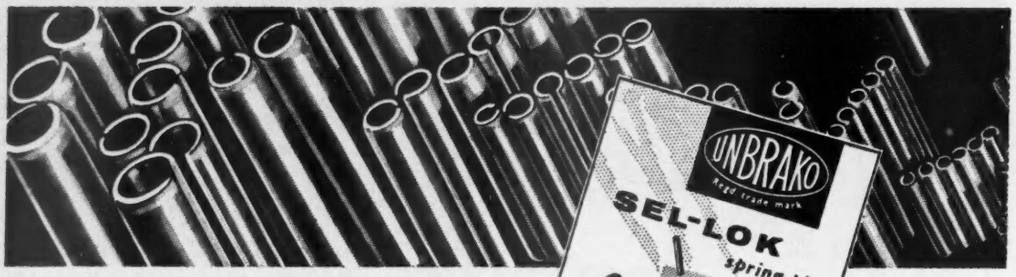

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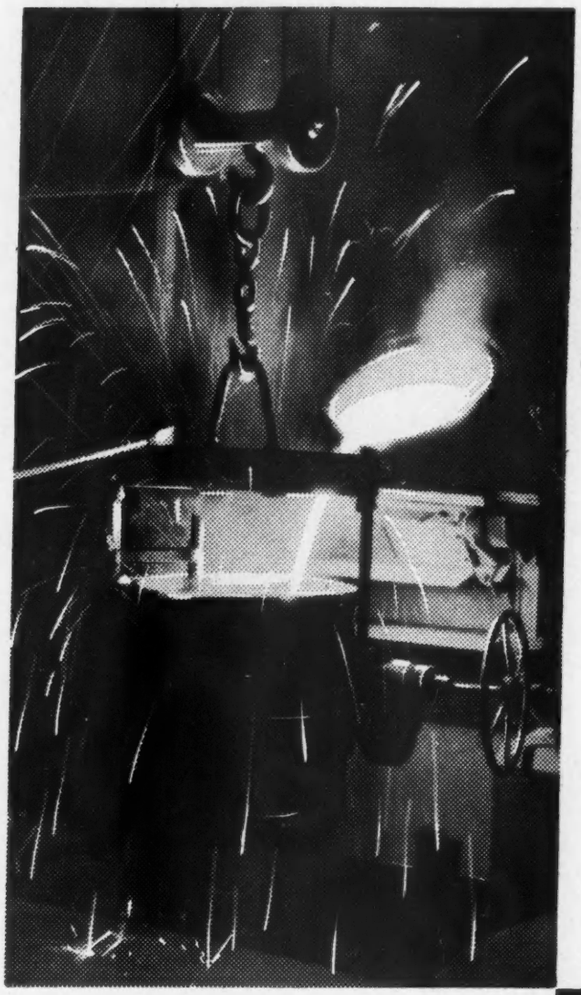

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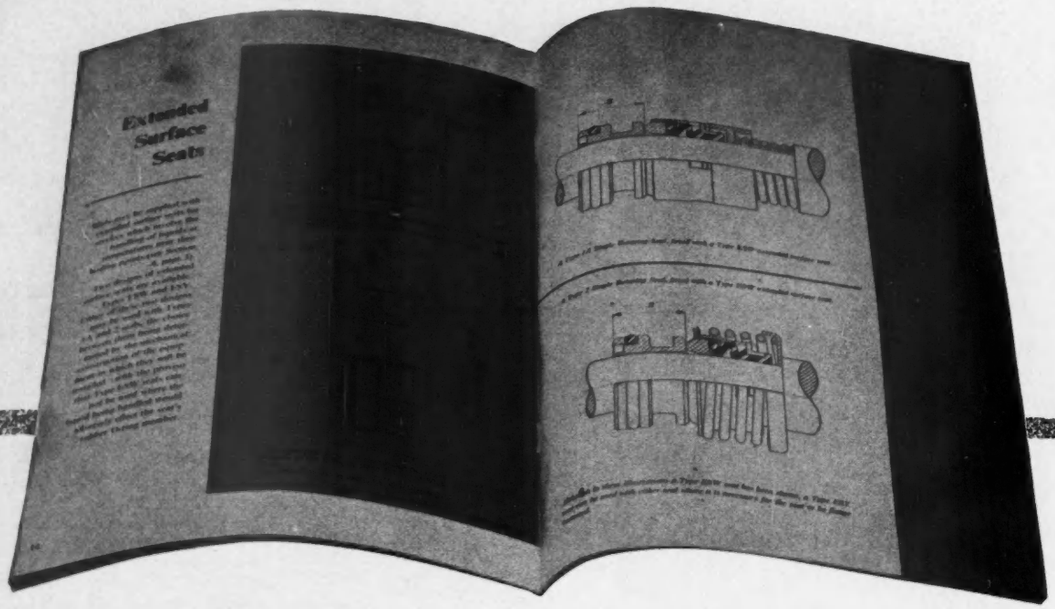
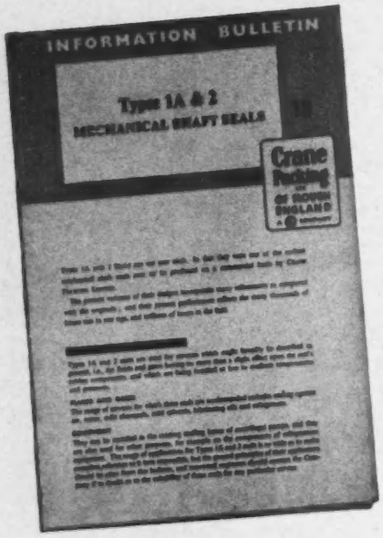


Mechanical Seals *Engineering* at its Best



These are General Purpose Mechanical Shaft Seals. That is to say, they have been designed for service conditions in which corrosive action, temperatures and pressures are not so pronounced as to call for one or another of our purpose-designed seals which are constructed with specially selected materials.

Both Types 1A and 2 Seals have been run for many thousands of hours in service, and their efficiency and reliability have been fully established.

This Information Bulletin, No. 18, contains a comprehensive description of the two seals and of the services for which they are recommended. There are also tables of sizes and other data, and a section is devoted to the newly developed extended surface seats, reference to which has recently been made in the editorial columns of technical journals.

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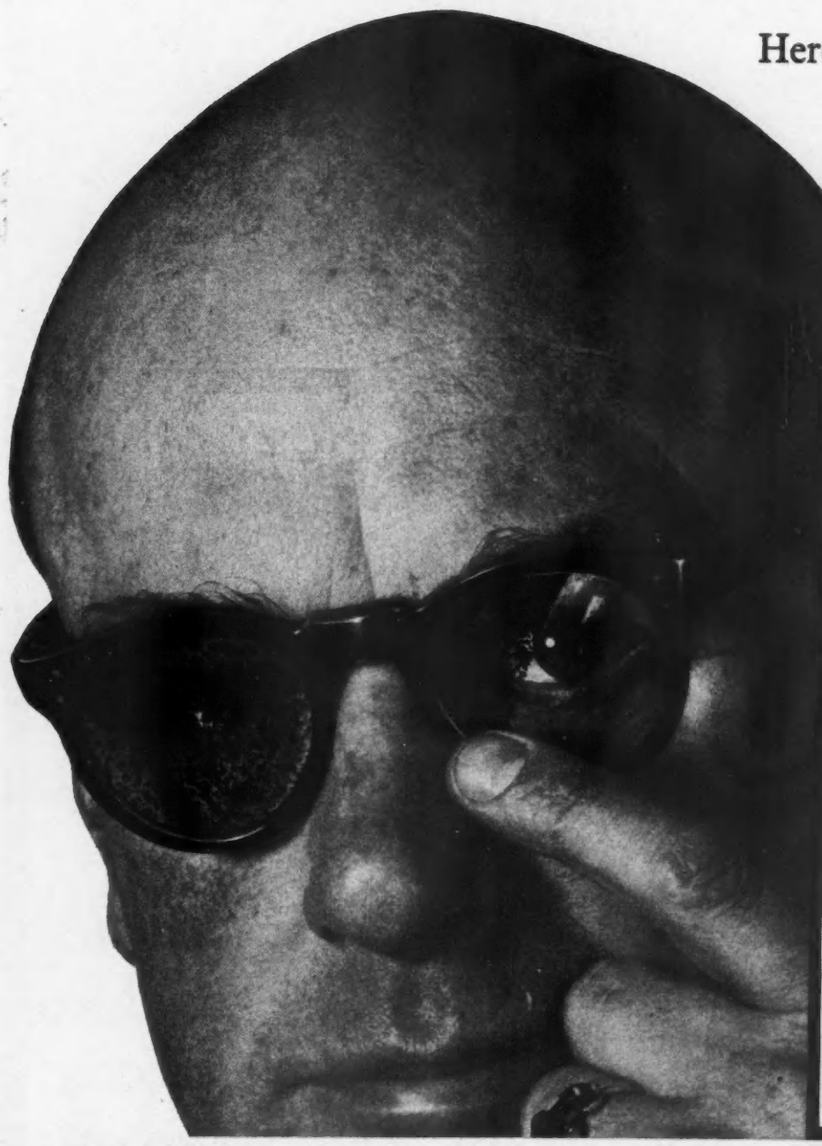

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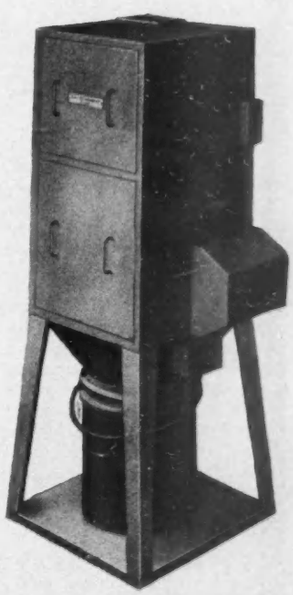
It's the finest dust control unit in the world. It's compact, powerful and made in a range of sizes —70 to 250 sq. ft. of filter area. Fans, filters and dust containers are made in a range of interchangeable sizes, giving a tremendous flexibility of application.



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Corrugated 'Perspex' roof lights in a building erected for Messrs. Edmund Taylor (Engineers) Ltd., Appley Bridge, Wigan, Lancs, by E. W. Tyler & Co. Ltd., Cannon Lane, Tonbridge, Kent.

Ideal lighting at low cost in this building —it has Corrugated 'Perspex' rooflights

MESSRS. EDMUND TAYLOR (ENGINEERS) LTD., makers of Taylor-made Laying Battery Cages and Poultry appliances, cut artificial lighting expenses in this store house. Corrugated 'Perspex' acrylic sheet roof lighting lets in all the light they need.

Corrugated 'Perspex' is inexpensive to install. It saves money on artificial lighting, and lasts indefinitely. It is tough, yet light and easy to handle. It is unaffected by the severest weather and withstands the corrosive atmospheres of industrial and marine areas.

Corrugated 'Perspex' is available in a wide range of profiles to fit most corrugated roofing materials. If diffused daylight is desired, Opal Corrugated 'Perspex' is available.

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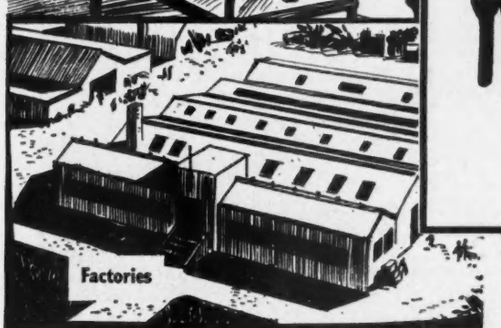
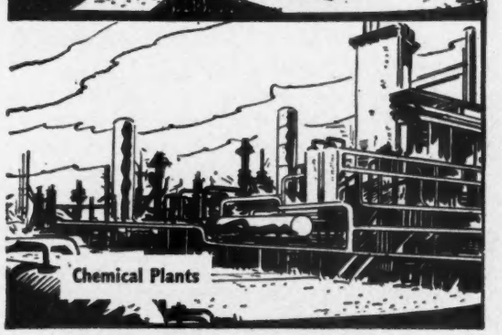
C.P. 169

TRUST* K.600 KOMPAKS to clear the air

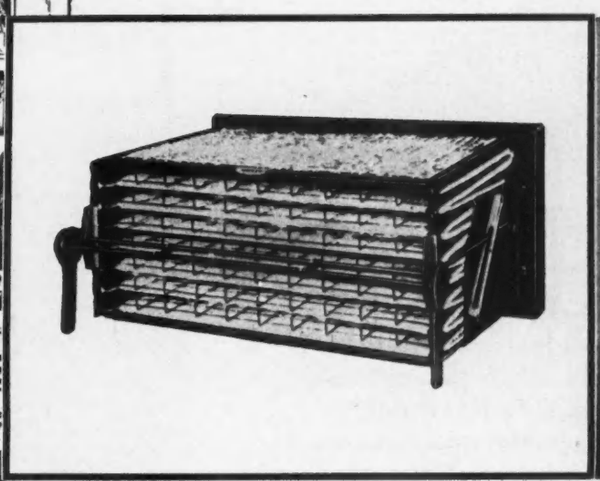


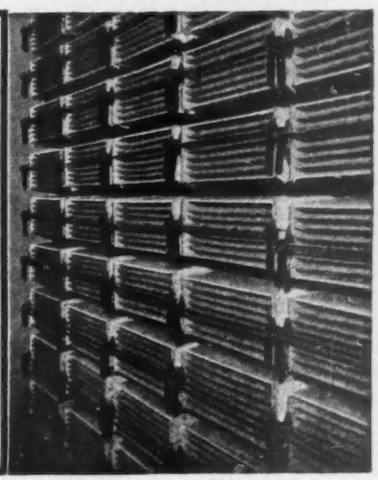


Perfected by years of research and development in the Vokes laboratories and in the field, the K.600 'Kompak' air conditioning filter is the most efficient as well as the most widely used of its type. Features which have led to its popularity include long life, reliability and extreme ease of maintenance.

Efficient air conditioning filters are essential in the provision of clean air inside buildings of all kinds. Impurities in the air supplied to factories can cause contamination of products or damage to valuable plant; in public buildings unfiltered air shortens the life of furnishings and decorations. Vokes K.600 'Kompaks' are installed in the air conditioning systems of large commercial and industrial office blocks, factories and engine test houses, public libraries and picture galleries, hotels and cinemas, concert halls, hospitals, multiple stores and establishments for scientific, pharmaceutical and photographic research and processing.

*** You can trust the K.600 'Kompak' because like all Vokes air filters it is fully tested in accordance with BSS.2831.**





Simply constructed and using an inexpensive, easily replaced filter medium, the K.600 'Kompak' has a normal rating of 600 cubic feet per minute with an initial resistance of 0.15 inches w.g. The actual velocity of the air passing through the developed area of the filter is only 22.5 feet per minute. Tested in accordance with BSS.2831, using highly penetrating test dusts, the 'Kompak' recorded an efficiency of 95% against Aloxite 50, and 93% against Aloxite 225.

The K.600 'Kompak' is ideal for general air conditioning, general ventilation and industrial air cleaning, particularly in areas where a sooty atmosphere prevails. It can also be supplied in flameproof and tropicalized versions, and a special super-efficiency type is available in which a layer of glass-wool backing the standard filter medium extends performance down to sub-micronic particles.

'KOMPAKS' FOR KELVINATOR

Kelvinator (Australia), who manufacture refrigerators for domestic and industrial purposes, use K.600 'Kompaks' as a second stage filter in their paint shop. The standard of paint finish acceptable is extremely high and efficient filtration of the dusty air is essential, particularly as the high gloss paint used accentuates any dirt defects. Since their installation the two banks of seventy filters each have given complete satisfaction, one bank having been in operation for two years without replacement of the filter medium. The intake (dirty) side of one bank is shown in the photograph above.

Write now for comprehensive literature on the 'Kompak' and Vokes' other air filters.

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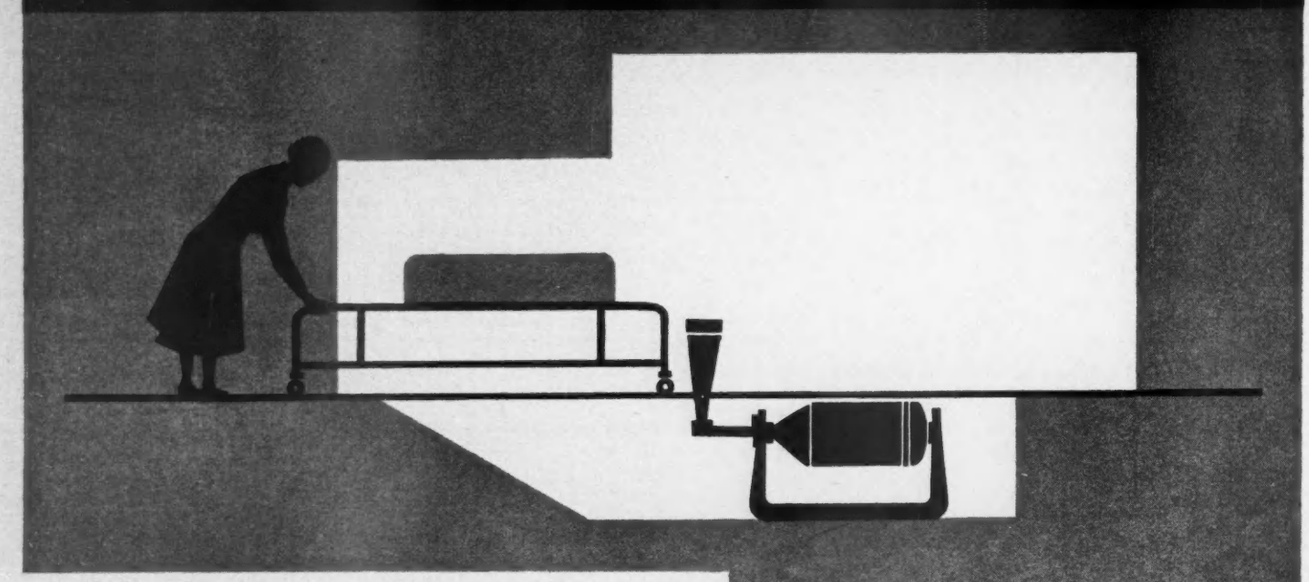
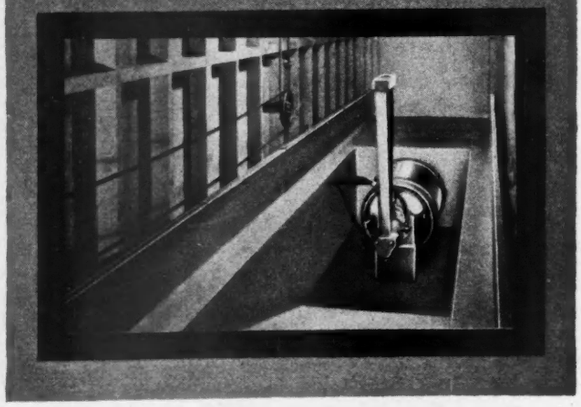


The LIGHTWEIGHT

RAYMAX 150

Here, five Raymax 150 units make an impressive and economic testing installation at the R.O.F. Patricroft. Components are tested in narrow space-saving leadply tunnels right on the factory floor. When examining longitudinal joints the component on the trolley is moved down the tunnel by means of a simple chain drive worked externally by the radiographer. As shown in the illustrations, the Raymax 150 is sunk in a pit thereby simplifying the protective measures necessary as the beam is always directed upwards against the roof of the tunnel.

Write for publication SP.7176/1. to your local AEI office or direct to:



In this installation the use of leadply tunnels only 4 ft. wide, instead of larger radiographic rooms, enables a considerable saving to be achieved in costly protective materials, in floor space and in time as the components do not have to be taken away from the shop floor. The gas-insulated Raymax 150 weighs only half conventional oil-insulated units. It gives high radiographic output, and its special design eliminates high voltage cables, rectifying valves and associated filament transformers.

AEI

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V/X 903

ENGINEERING Impact

of Another Little Touch on the Brakes

Six per cent Bank Rate. That is only one per cent behind the seven per cent imposed in September, 1957. And company chairmen are still reporting how not until well into 1959 did they recover from the depressed conditions of 1958.

Are we heading the same way again? This time it is almost certain that the brakes have been applied much sooner. Accordingly it can be hoped that the economy will respond much quicker and begin moving ahead again with that much less delay.

The Chancellor of the Exchequer has not only made it more difficult, and more expensive, to go to the bank and raise a loan for that new car or works extension. His activities in putting up the cost of money will have a much more direct way of stimulating exports than simply slowing up home sales.

Stocks

Between them the stocks held by manufacturers and distributors in the United Kingdom increased by £203 million in the first quarter of this year. Last year they increased by only £149 million in the whole twelve months. The most acute comparison is of manufacturers' stock only. These increased by £4 million in the first quarter of 1959, and by £121 million in the first three months of this year.

All these stocks are in a very real sense money waiting to be used. Putting up Bank Rate makes it at once more difficult to sell the product on the home market, more important to turn the stocks into saleable goods and get them sold.

So there is every incentive to close the gap that has been growing between our soaring import bill and the laggardly export results.

Whether this is the best way to obtain the desired result is quite another question.

The powerful and strongly established will still be able to apply the resources of the nation to whatever they choose, and that will not necessarily be in the overseas markets. The small, developing concern, ploughing back its profits and with years to go before its material returns are up to what the city regards as reasonable, will now be struggling harder than ever.

More absorptions by the bigger units will occur unless this indiscriminate blanket is fairly soon taken off. No doubt some of these mergers do the larger group good, but there are disadvantages as well as gains.

It is a paradox that some of the electronics and high grade machine tools firms, to whom industry, faced with shortage of labour and now with dearer money, will increasingly turn, are themselves among the most likely to be affected by the new interest rates.

18 Months of Hoping For the Best

No less important than the rise in Bank Rate is the Government decision that investment in the public sector of the economy shall remain in 1961–62 at the present level.

Since the current rate of spending on the Coal Board, the electricity industry and so on is running at above £1,700 million a year, this is not exactly a standstill order. But it is likely to be an order which results in development not going on in the most useful possible way.

Any traveller in Europe sees with his own eyes the great use made by the Continental railway systems of purpose-built goods wagons of a splendid and confident range of applications. The same traveller, returning to Britain, finds too many of the same old trains of wooden sided trucks shuffling hopelessly along. Does the new order mean that British Railways is going to be further than ever from equipping itself for a full part in an industrial transport service?

Already the decision to make great sacrifices in the open-cast programme has raised the capital costs in coal mining above what they could have been. It is no argument to say that this makes more jobs. It does for the time being.

But our share of world trade is declining. And prices have something to do with it. If cheaper coal from opencast mining was used to keep down export prices, the final result might well be of more jobs all round than may follow from featherbedding practices that lead to pricing ourselves out of one market after another.

Presumably it is still the case that industrial activity is to function at a level far above the capacity of the roads to handle all the goods produced. But now the reasoning behind the lack of a road policy begins to be apparent. When there is too much activity, raising Bank Rate holds everybody back. And that is just what the road system has been doing for years.

The Fractional Maid of All Work

Now that everything is motorised or remote controlled, the number of fractional horse power motors installed must be astronomic. The turnover for the industry was £12 million last year—a lot of motors, and not many of them replacements.

This month the first annual report of the Fractional Motor Conference was published, not a large document, but a record of useful progress during the first year of existence.

The conference sets out to improve the efficiency of the industry; to study and exchange information upon market requirements at home and overseas; to provide an authoritative body of manufacturing opinion and experience which can represent the industry to the Government and others; to cooperate towards the establishment of British and International standards; and also to study and, where appropriate, to make recommendations, on overseas and other specifications.

As regards standards, work has already begun on revision of specifications and the conference is concerned to establish and maintain standards for the safety of motor driven domestic appliances with which the industry is so closely connected.

of Three Pronged Attack by NEL

The first annual report of the National Engineering Laboratory's Steering Committee, appointed last April, has now been issued. The main feature of this report is a new three-point plan aimed at optimising the research effort available.

The first plan is to cut down on the number of projects being tackled, in the hope that concentration of effort in fewer channels will pay quicker dividends. In addition to getting more immediate results, it could also be argued that the net value over a given period will be greater, since small and frequent increments of engineering knowledge do more for modern industrial progress than larger, but considerably less frequent ones.

The second plan stems from the first. Since the aim now is to get useful data into industry as quickly as possible, it follows that the types of projects to be tackled should be those showing signs of immediate practical benefit. In this respect the committee have named three in particular: investigations in the machine tool field, the development of hydrostatic power transmissions, and work on the cold extrusion of steel.

The third prong of this new plan of attack is by way of being a safeguard against the obvious limitations of the other two. In the words of the committee, they are "anxious that the Laboratory should look to the future development of industry." They have therefore stated that some proportion of the effort available must be spent on the longer term type of research.

This emphasis on practical objectives in long term research seems at first sight to be anomalous with the generally accepted philosophy of research. However, when one considers the fierce international competition which is nowadays geared to industrial development, it becomes obvious that expediency must, at least for the moment, be the paramount consideration.

Liberty Ships at Large

One of the biggest headaches for the shipbuilding industry is the large number of Liberty ships laid up in British and European harbours. Until these and other obsolete vessels are scrapped the prospects for the building yards remain doubtful. A report that these American built ships are now being bought up for further service comes as a hard blow to the shipbuilders.

The buyers are all among the newly developing countries anxious to build up merchant fleets quickly and cheaply. Communist China is the biggest purchaser but Pakistan, Nigeria and Ghana, and nearer home Turkey, are also reported to be in the market. The economics of the Liberty ship are fairly straightforward.

A 17 year-old vessel sells for about £100,000 and has a life of three or four years. After that it fetches around £60,000 in the scrap yards. A newly built ship of the same tonnage would cost seven or eight times as much. So for countries with not much money to spend and with jobs waiting to be done the Liberty ships provide an easy way out. Although many of these ships would not pay their way in competitive world transport conditions they can hold their own in some of the domestic markets of the Far East.

If too many of these ships get back into service it will create considerable difficulties not only for the shipbuilders who are hoping to build replacements for them, but also for the shipping lines. The name Liberty ship, which bore so much promise of better times to come in the war has a harsh sound to today.

A Chance for Brilliant Innovation

Atlantic crossings in five hours flying time should be, have even been said to be, a blessing to the traveller. Their enjoyment is sadly upset by the difficulties in getting away from the major airports and, at the end of the hop, in getting down again.

On a recent Boeing 707 flight from Idlewild the captain was required to hold his aircraft, engines eating away at the fuel, for so long on the ground, that another ten minutes or so in the queue and he would have had to return to the apron to be topped up.

This is expensive for the airlines. For the passenger it is anything from infuriating to mildly alarming. Yet where is the answer?

Perhaps an engineer in full possession of all the airfield operating finesse has the germ of an idea that will render holding the modern giants for an hour or more on the runway with all engines running as obsolete as the man walking before the early cars with a red flag.

and Too Comfortable a Bed Ever to Get Up?

There is something of foreboding about the traveller's tale told by Mr. G. F. Anderson, an enterprising Australian managing director.

For five weeks he travelled vigorously around United Kingdom firms. He was seeking British manufacturers ready to expand their companies into Australia. He also wanted to find companies in the old country who wished to have their products made under licence there.

Mr. Anderson travelled and interviewed with a will. He found not one company wanting to make a start in Australia. Not one keen to have its product made there and part of the profits remitted.

There are certainly disadvantages in moving into a far flung Dominion like Australia. And, so Mr. Anderson gathered, things are currently so good in the home market that interest in such development is not high.

But there are non-British firms seeking to set up in Australia. And the potential in South-East Asia and the Pacific is as enormous as the distances—or the populations. There may be losses to be made in Australia in the early years. Profit margins have not declined in the United Kingdom to the point where the companies that have established themselves on the island continent cannot show encouraging figures for their global operations.

Perhaps Mr. Anderson's discouraging experience was unfortunate. Evidence of a passing phase—from which we shall recover.

Organic Coatings Lessen Metal Fatigue

US National Bureau of Standards has investigated the effects of polar and non-polar organic compounds on metal fatigue. The investigation showed that coatings of long-chain polar substances greatly increase the fatigue strengths of steel, magnesium, and copper-beryllium alloys. On metal surfaces the polar compounds apparently form tightly packed monolayers that act as a barrier to water and oxygen molecules.

It is well known that environment influences metal fatigue. Even the mild corrosion that occurs when fatigue tests are run in a laboratory atmosphere may affect test results. A number of studies and experiments have shown that certain types of organic compounds afford protection against corrosion under normal unstressed conditions. Owing to the fact that these compounds readily lend themselves to mechanism studies, H. E. Frankel, J. A. Bennett, and W. L. Holshouser of the Bureau staff undertook the present investigation to ascertain their effect on fatigue behaviour.

Cylindrical specimens were machined in which the longitudinal radius of curvature was held constant at 3·5 in. Minimum diameter of the reduced section was 0·310 in for magnesium and 0·250 in for the other alloys. All of the experiments were conducted on rotating-beam fatigue testing machines of the R. R. Moore type, which apply pure bending moments to the test section. Specimens of six different alloys were tested to fracture under one of the following conditions:

Substance	*Formula*	*Type*
n-Hexadecane	$CH_3(CH_2)_{14}CH_3$	Non-polar
Xylene	$C_6H_4(CH_3)_2$	"
Benzene	C_6H_6	"
Oxtyl alcohol	$CH_3(CH_2)_6\,CH_2OH$	Polar
Dodecyl alcohol	$CH_3(CH_2)_{11}\,OH$	"
Dodecylamine	$CH_3(CH_2)_{11}\,NH_2$	"
Oxtadecylamine	$CH_3(CH_2)_{17}\,NH_2$	"

cleaned and dry; coated with or immersed in an organic substance; immersed in water, either in the coated or uncoated condition. The organic substances used are shown in the table.

The water and non-polar liquids either had no significant effect or caused a decrease in the fatigue life of the specimens. The polar organic

compounds, however, caused an increase of over 600 per cent in the fatigue life of the magnesium alloy, stressed at 12,500 lb per sq. in; an increase of approximately 250 per cent in the copper-beryllium alloy, stressed at 50,000 lb per sq. in; and an increase of approximately 200 per cent in the steel alloy, stressed at 100,000 lb per sq. in. These compounds had little, if any, beneficial effect on the other three alloys, titanium, aluminium, and stainless steel, probably because

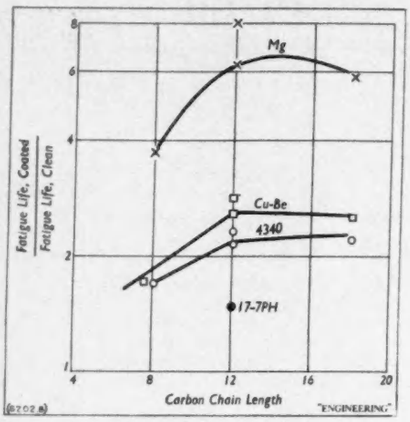


Fig. 1 (left) Magnesium specimen coated with an alcohol before it is fatigued. Uncoated control specimen is in machine.

Fig. 2 (above) Effect of polar organic compound on fatigue life of four alloys.

of the strongly adherent oxide films that form on these materials.

The results showed no appreciable difference between the specimens that were immersed in the polar substances and those that were merely coated with them. Coating the specimens with one of the substances, dodecyl alcohol, and then testing in a tap water environment resulted in as much improvement as obtained in air.

Compounds having chain lengths of 8, 12, and 18 carbon atoms were studied. Of these substances, those having 12-carbon chains apparently gave optimum conditions. The comparison also showed that the type of polar group does not appear to be as important as the number of carbon atoms in each molecule.

Reinforced Plastic Moulding for Washing Machine

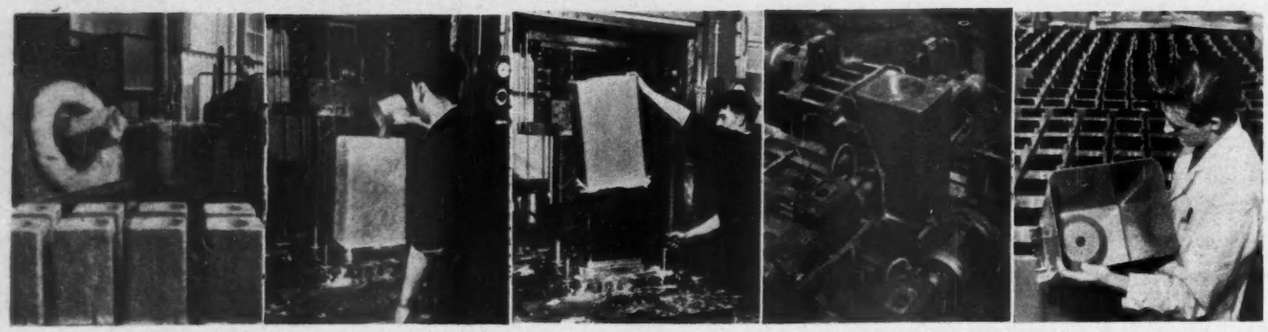
The water container for the spin dryer compartment of the new AEI-Hotpoint Supermatic washing machine is press moulded in Feroglas, a glass reinforced plastic. It is produced from matched metal moulds in quantities which may well represent the highest production rate outside the USA for such a single moulding.

In this particular instance, the firm name several advantages over production in metal. First, the deep draw required and achieved in this press moulding would have been extremely difficult to reproduce in metal. This will be appreciated from a consideration of the dimensions which are 14⅛ in by 11¼ in by 21¼ in deep. The draw permitted was 1°21′ at a wall thickness of 0·080 to 0·090 in. The container is stronger yet lighter in weight than if made in metal.

Feroglas has excellent chemical, weather and corrosion resistance. It is therefore ideal for production of water containers and similar products in contact with water. The material will withstand a great deal of rough treatment. A further advantage of moulding in reinforced plastic is that overall cost is very competitive in medium range production runs.

In domestic appliances and similar equipment the use of Feroglas reduces drumming and noise usually associated with sheet metal.

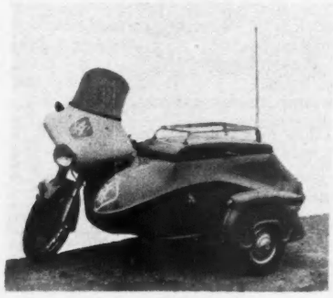
The illustrations below show five main stages in production of the mouldings. For designs where it is difficult to tailor the reinforcing mat to fit, this method of spraying glass on to a preforming machine is well proven. On to this is sprayed a binder which gives the preform strength for baking and placing into a female mould. The second illustration shows pouring of the liquid resin on to the preform so that when the heated and matched mould is lowered the resin is forced around the preformed glass to fill the gap. After a few minutes for curing, the moulding is blown off the male mould and cooled off on special fixtures to counteract any tendency to distortion. Flash is removed, 30 holes are drilled without supervision, and ancillary fittings attached before final inspection



Glass Reinforced Polyester for Sidecars

All RAC motor-cycle patrols will eventually be equipped with a new sidecar made from glass-fibre reinforced Bakelite polyester resin.

The sidecar is designed and made by Watsonian Sidecars of Birmingham, is completely



weather resistant, needs no painting and requires the minimum of maintenance.

The use of reinforced resin gives much greater design freedom, since it allows the production of complex curved shapes which cannot easily be fabricated in metal—a factor which has greatly contributed to the streamlined appearance of this model. The RAC report that many of the new sidecars have already done over 20,000 miles of service without any serious deterioration.

Bakelite Limited, 12-18 Grosvenor Gardens, London, SW1.

Water Soluble Resins in Stoving Primers

Paint systems in which water is used as the carrier are of great interest to both paint manufacturers and users. One type, the emulsion paint, is now well established but a much wider market exists for resins which are water soluble and not merely water dispersible.

British Resin Products has now developed a water soluble resin as a vehicle for industrial stoving primers. The performance of the resin is comparable with that of conventional primer vehicles but the resin itself possesses many advantages over the latter type by virtue of the total replacement of the usual organic solvent by water. Furthermore, this Epok resin may be thinned to any extent with water alone.

Probably the outstanding advantage offered by water soluble or water carried resins is the elimination of the fire risk associated with the use of solvents. The occurrence of some serious fires, particularly in the motor car industry, has stimulated the demand for less flammable paints. Additional advantages associated with the elimination of fire risk include the possibility of the use of cheaper equipment, particularly electrical installations, and the benefits which may be obtained from lower fire insurance premiums.

Elimination of organic solvents from industrial paints and their replacement by water reduced hazards to the health of operators using the paints. The substitution of water for organic solvents may also eliminate the need for possible costly expenditure on extraction equipment when regulations governing atmospheric pollution are generally introduced.

Water is, of course, much cheaper than the cheapest organic solvent and does not have to be transported and stored in special compounds as do conventional thinners. Additional economy results from thinning the paint with the water from wet backed spray booths, if these are used, since this is, in effect, a dilute solution of overspray.

From the point of view of paint manufacture water soluble resins have the advantage over emulsions of acting as dispersing agents, so that pigments may be milled directly with the resin with a consequent saving in milling time. Again, compared with emulsions, water soluble resins are, in general, more stable to repeated freezing and thawing thus requiring less critical conditions of storage and transport during cold weather.

Primer films based on Epok A1700 are flexible and possess excellent humidity and salt spray resistance, both alone and when overcoated with conventional topcoats. They are suitable for use in many industrial applications including car bodies, machinery and office equipment and for such domestic appliances as cookers, refrigerators and washing machines.

Another new material called Durusol, made by Arthur Holden and Sons, is based on resins of this nature. At a recent demonstration in a large motor works, painters saw the material being thinned with ordinary water and also witnessed a part still wet from a water cleaning rinse being immediately and successfully coated with the new material.

Panels coated with Durusol primers only, subjected to corrosion cabinet tests of 100 per cent relative humidity at a temperature cycle of 42 to 48° C for over 1,300 hours, showed no sign of attack by corrosion either on this film or on the metal to which the Durusol was applied.

The ideal stoving conditions for the material are 340° F for 20 to 30 min when the maximum corrosion resistant properties are obtained.

The manufacturers state that Durusol has a wide stoving range and will effectively cure in radiant heat or infrared providing good air circulation is available. They point out that in these conditions the stoving time will necessarily be governed by the weight of material and the contour of the article to be coated.

British Resin Products Limited, Devonshire House, Piccadilly, London, W1.
Arthur Holden and Sons Limited, Bordesley Green Road, Birmingham 9.

New Barrier Materials

A laminate of long-fibred cotton cloth, sheet aluminium foil and polyethylene is not being marketed in Britain by Claritude, a subsidiary of the large French company Saint-Gobain of Paris. Specimens of the material, of which there are several finishes, can be seen in a display recently installed by Claritude at the Packaging Centre.

The three components of the barrier material, known as Silgelac, are laminated to form an airtight sheet which, when used as an outer wrapping, is extremely resistant to abrasion, crushing, rough handling and the weather. It combines the special protective characteristics of each material, and the resultant composite costs less than the only approximate equivalent available here.

To seal the envelope the edges of the Silgelac are heat-welded with a simple hand-tool. When the machine, instrument or other article to be packaged has to be transported a long distance or stored, it is essential to inset one or more dessicants before the envelope is closed.

Suitable dessicants are either of silica gel or activated clay, their function being to absorb the residual humidity enclosed in the airtight package at the moment of sealing, and the very slight humidity which may pass through the barrier material in the course of time. The dessicant is inert material and there is no danger of damage to the enclosed product.

On the Continent Silgelac has been successfully used for the packaging of aircraft engines to be stored for long periods in the open air. Other products which can be effectively protected include explosives and cartridges; chemicals and pharmaceuticals; watches and clocks; electrical and electronic equipment; radiographic, radiological and optical equipment, foodstuffs; mechanical and metallurgical products; clothing; photographic materials and equipment; and heavy machinery for factory use.

For storage the barrier material has been found effective in protecting machines temporarily unused; delicate spare parts; circuit breakers; ball bearings; blades and points of tools; as well as pictures and other valuable objects.

Claritude Limited, Packaging Centre, 50 Poland Street, London, W1.

Araldite Based Silver Preparation

Johnson, Matthey announce that research work carried out in collaboration with CIBA has led to the development of two additions to the JMC range of thermosetting silver preparations. Both these preparations are based on Araldite.

FSP43 is a surface coating preparation for application by brushing; FSP49 is a conducting cement. Each is supplied in the form of two separate components which are mixed together immediately before use.

The mixed components must be cured at a minimum temperature of 80° C and will adhere to most materials that are capable of withstanding this temperature, including glasses, ceramics, graphites and many plastics. The films, after curing, are extremely hard, have high electrical conductivities and are highly resistant to water and organic solvents. Moreover, the film produced by FSP43 can also be electroplated in many conventional acid baths.

Johnson Matthey and Company Limited, 78 Hatton Garden, London, EC1.

Reinforced Plastic Blanking Covers

Specially moulded blanking covers are now being moulded by the Plastics Division of Hunting Aircraft to protect the air intakes on the well known Hunting Jet Provost Trainer.

These covers, which are moulded with Cellobond polyester resins, made by British Resin Products, and glass fibre, are fastened to the air intakes as part of the edge of the covers to a tight fitting so that foreign matter cannot enter the intakes and cause subsequent damage to the engine.

Glass reinforced polyester has proved ideal for this application because not only will it with-

stand the rough handling inevitably suffered by ground equipment, but it is light in weight, will not corrode and requires no maintenance. In the event of an accident, damage can be easily and swiftly repaired.

British Resin Products Limited, Devonshire House, Piccadilly, London, W1.

Plain Words

By Capricorn

A POPULARLY accepted picture of engineering is that it is the application of science. There is an unbroken chain, so it is thought, from the genius working on fundamental research, right through the design department and the production shops, to the sales organisation and the affluent consumer. A simple, tidy picture. But it's not true.

Engineering is greater—and more complex—than a layman would conclude from that concept. Of course, it is easy to see why the false picture has been accepted: because it is true for one view of part of engineering. It is true for the historical view of those branches of engineering that have developed directly from a break-through in scientific research. Atomic power has its historical roots in 19th and 20th Century physics, and there are other examples that will spring to mind.

Much the more usual sequence in engineering starts with someone perceiving a need or want in practical terms. The time is propitious for what he has in mind. New techniques, new materials, new market conditions—some or all of these factors have created a situation which is favourable to a new development in engineering. From that point on, attention is focused on the activity which is central to all engineering—design and development. That is at the centre of the engineering spectrum. At one end of the spectrum is scientific research, to which the engineer turns for precise guidance, and at the other end is the marketing. To engineer a new development is to manage and integrate the whole of this work. And that requires a breadth of experience and knowledge that is not automatically bestowed by the award of a degree or diploma.

The education of the engineer starts with the only aspect that can be taught to a complete novice—the science of the profession. The science can be learnt before acquiring a personal experience of engineering as practised. It can be taught in the universities and colleges. The Cambridge man takes the Mechanical Sciences Tripos, but he graduates as a Bachelor of Arts. His book knowledge is of science, but before he can call himself a fully-fledged engineer he must have time to learn the art of the profession. During that time, he will find that a considerable part of engineering uses no more mathematics and science than is taught at school.

I hope the university and college teachers of engineering always bear in mind this essentially practical nature of the profession and the industry. Engineering, like politics, is the art of the practical, and although it is making more and more use of science, we are a long way off reducing all engineering to a scientific basis.

If we ever reach that computers' paradise, engineers will have worked themselves out of a job.

Letters to the Editor

Speaking Our Minds

SIR, All would agree with Mr. Hugh Clausen (ENGNG., 17 June '60, p. 808), that invention can only reach its market through excellence in design, and that this requires 90 per cent of the technical work involved, but who is it that should direct the designer's highly skilled efforts? If commerce directs then commodities with a short life will flood the market. If scientists and designers direct, then fear of loss of reputation will make goods so expensive as to price them out of the markets. It has, in the past, been the inventor who has not only initiated research in the desired direction but who has also maintained that nicety of balance between the opposed forces of commerce and professionalism as to maintain the optimum service to the consuming public.

Today, however, with the growing power and complexities of commerce and professional technocracy, the inventor is being rapidly pushed out of his province. Let it be admitted, the task which the inventor sets himself is daily becoming more difficult. It is becoming too difficult, moreover, for the Institute of Patentees and Inventors to shoulder his burdens for him. But, to face facts, we must see that it has also become too difficult a problem for the Government's departments to handle. A great number of inventions go abroad for their development. Others, from time to time, receive official backing which a free-lance inventor would leave severely alone after a brief assessment with the slide-rule. None, excepting the successful inventor, seems capable of assessing an invention in its embryonic stages.

More often than not, the good invention, as judged by the average commercial or scientific expert, looks impracticable. The great need, therefore, is for a body of super-experts to assess, guide and develop, with utter impartiality, the invention through its embryonic stages. The present appalling situation arises from the lack of these super men which the educational system, commerce and industry fail to provide. Indeed, the only sure training ground for such men as will assess an invention impartially and adequately in its embryonic stages, is the drawing board and workshop. Hence, the sanity of the recent Institute of Patentees and Inventors' innovation that under its auspices inventors and designers should meet to discuss one another's work, thus to provide the right type of criticism and, eventually, to direct the inventor to the best expert advice and market outlets.

This approach is quite the right one, but it needs far more forceful handling than the Institute of Patentees and Inventors is able to muster at present. To be able to provide the necessary technical advice it must first have the full backing of the nation's inventors.

Truly yours,
ARTHUR W. CAPPS.

Edgcumbe,
Crowthorne, Berks.
22 June, 1960.

Public Relations

SIR, I was interested to read the remarks made in your editorial columns on my recent book entitled *On the Record* (ENGNG., 3 June '60, p. 749).

I think it is important to remember that a public relations campaign may be initially successful even if a change in Government means that later on the policy is completely altered. I think that you will agree that that is a matter beyond the control of a public relations officer. At the time, the British public was fully aware of what was going on in the steel industry and the reasons why the Socialist Government decided to nationalise it.

In reply to your question as to whether or not a public relations campaign achieves its object, I think an interesting example is that one of our clients has increased their company's sales by over 100 per cent since retaining my company as their public relations consultants. Naturally, this cannot solely be attributed to public relations, but I feel it is fair to say that there must be some relationship between the two factors.

Yours faithfully,
MIKE WILLIAMS-THOMPSON,
Managing Director.

Sidney-Barton Limited,
Field House,
Breams Buildings, London, EC4.
21 June, 1960.

"Poor Devil"

SIR, With reference to the On the Shelf article by Mr. Frank H. Smith (ENGNG., 17 June '60, p. 833), you may like to make the acquaintance of the "poor devil R. W. Clarke" referred to therein. I am that "poor devil," and would like to say that I am intensely amused at the little write-up about me and *Radiation Chemistry Abstracts*—it really gives me a good laugh, and it was really worthwhile compiling the document to get this kind of review.

Will you please inform F. H. Smith, however, that the document to which he refers is just a spare-time job for me (or is so regarded at Harwell). In addition, the "poor devil" has to look after the scientific needs of several hundred scientists at Harwell and elsewhere. In his spare time he is also an organist, pianist (makes records of both), dancer, player of tennis, married with attendant responsibilities (including painting, decorating and gardening), breeder of world-famous Siamese cats, etc. He also undertakes quite a lot of spare-time book writing on atomic energy.

As regards seeing the "light of a Berkshire day," F. H. Smith may like to know that, owing to the location of the new Library at Harwell, far from his office, the "poor devil" sees a lot of the Berkshire Downs.

Please tell F. H. Smith that the fourth supplement to *Radiation Chemistry* will shortly appear and will comprise 500 pages!

Yours sincerely,
R. W. CLARKE.

United Kingdom Atomic Energy Authority,
Harwell, Berkshire.
23 June, 1960.

Concrete Strengths

SIR, In his recent letter, Mr. M. S. Thompson shows some very interesting graphical results for concrete cubes cured in warm water (ENGNG., 27 May '60, p. 713). I have scaled off values from his Figs. 1 and 2, and have replotted them upon a log maturity base in the accompanying Figs. 1 and 2 reproduced on the opposite page.

My Fig. 2, derived from Mr. Thompson's Fig. 2, is very similar to Figs. 2, 3, 4 and 5 in my article "Concrete Strength Near Freezing Point" (15 Jan. '60, p. 78), having a change of slope at a maturity of approximately 750° F-hr.

The accompanying Fig. 1, derived from Mr. Thompson's Fig. 1, is of a slightly different shape, but this again shows a change point in slope at approximately 700° F-hr. From the very high rate of growth of strength, it may be presumed that a more finely ground cement than usual was used for this concrete, coming within the bounds of a rapid-hardening Portland cement.

In both cases, for the limited values available (and scaled values at that), the relationship strength/log maturity appears to be a straight line at maturities greater than 750° F-hr. Would Mr. Thompson be kind enough to publish his original results plotted upon a log maturity base, with any other results he may have for the same

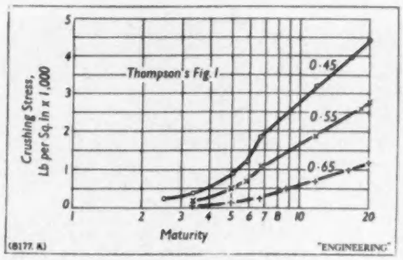


Fig. 1 The unit of maturity is 100 °F-Hr.

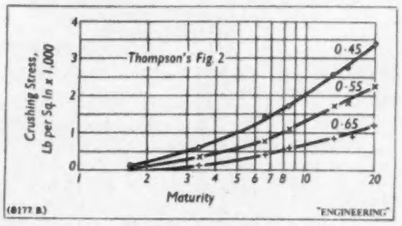


Fig. 2 The unit of maturity is 100 °F-Hr.

concretes at greater maturities, for example, 28 days at 64° F?

Yours sincerely,

J. M. PLOWMAN.

48 Bradmore Way,
Brookmans Park, Hertfordshire.
18 June, 1960.

Events in Advance

Canada Comes to Britain's Building Exhibition

THIS year's Building Trades Exhibition, the 23rd of the series, is once again to be held in the City Hall, Deansgate, Manchester, and will run from 11 to 22 October next.

The very considerable sales potential of these events, which now take place only biennially, is indicated by the many large concerns that have signified their intention of taking part in this year's event as exhibitors. Among the 80 or so organisations coming under this heading, may be mentioned the General Post Office and the Department of Scientific and Industrial Research. There will also be an official display by the Canadian Government, which is certain to attract a good deal of attention but, so far, no details of this exhibit have been disclosed.

It is understood that the DSIR will be showing a large number of novel and up-to-date ideas for developing and improving techniques in the industry, as well as portraying their current research programmes. Examples of the latest crawler and wheeled tractors will be displayed.

As previously, the organisers are Provincial Exhibitions Limited, City Hall, Deansgate, Manchester (Tel. Deansgate 6363), from whom further details may be obtained.

Elliott's Courses on Electronic Digital Computers

In view of the success which attended the recent series of courses on their 802 and 803 electronic digital computers, arrangements have been made by the Computing Division of Elliott Brothers (London) Limited to hold a further number of one-week programming courses on this subject during the coming autumn.

These additional courses, five in number, will run respectively, from 29 August to 2 September; from 26 to 30 September; from 17 to 21 October; from 14 to 18 November; and from 12 to 16 December. In each case, students may remain at Elliotts for a second week in order to gain practical experience, without additional charge. The first course, from 29 August to 2 September, is intended principally for members of universities and technical colleges.

Applications to take part in these courses should be made to the manager-public relations, Elliott Brothers (London) Limited, Elstree Way, Boreham Wood, Hertfordshire (Tel. Elstree 2040).

Exhibitions and Conferences

Nuclear Science for Peaceful Purposes, Symposium.—Wed., 6 July, to Tues., 19 July, in Hauradan, Iran. Will cover recent developments in the applications of nuclear science for peaceful purposes. Apply to Dr. M. L. Smith, CENTRO Institute of Nuclear Science, PO Box 1828, Tehran, Iran.

Radio and Television Exhibition, 27th National.—Wed., 24 Aug., to Sat., 3 Sept., at Earl's Court, London, SW5. Organised by the Radio Industry Exhibition, Ltd., 59 Russell Square, London, WC1. Tel. MUSeum 6901.

Knitting Wool Trade Fair, Second.—Mon., 5 Sept., to Thurs., 8 Sept., at the City Hall, Manchester. Apply to the exhibition organiser, *Knitting Wool Review*, 222 Strand, London, WC2. Tel. FLEet Street 1253.

Statistical Quality Control, Course on.—From Mon., 5 Sept., for three weeks, at the College of Advanced Technology, Birmingham. Apply to the Bursar, College of Advanced Technology, Gosta Green, Birmingham 4.

Watch and Jewellery Trade Fair, Sixth International.—Mon., 12 Sept., to Fri., 16 Sept., at Olympia, London, W14. Organised by Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Film Congress, 14th International.—Fri., 16 Sept., to Sat., 24 Sept., in Prague. Organised by the International Scientific Film Association. Apply to the Scientific Film Association, 3 Belgrave Square, London, SW1. Tel. BELgravia 6188.

Factory Equipment Exhibition.—Wed., 21 Sept., to Sat., 1 Oct., at Belle Vue, Manchester. Organised by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Electrical Fair.—Fri., 23 Sept., to Sat., 1 Oct., at Alexandra Palace, London, N22. Organised by Electrical Fairs Ltd., 6 Museum House, 25 Museum Street, London, WC1. Tel. MUSeum 3450. (*Deferred: it is likely that a new venue, in central London, will be arranged.*)

Natural Rubber Research, International Conference on.—Mon., 26 Sept., to Sat., 1 Oct., in Kuala Lumpur. Sponsored by the Rubber Research Institute of Malaya, with the support of the Government of Malaya and the Rubber Producers' Council. Apply to the secretary, Rubber Research Institute of Malaya, PO Box 150, Kuala Lumpur, Malaya.

Purchasing Officers' Association "Minibition."—Thurs., 29 Sept., to Sat., 1 Oct., at Scarborough. Apply to the secretary, Purchasing Officers' Association, Wardrobe Court, 146A Queen Victoria Street, London, EC4. Tel. CITy 3841.

Industrial Reconversion, Conference.—At end of Sept., in Luxemburg. Organised by the High Authority of the European Coal and Steel Community. Expected to last about five days. Apply to the offices of the delegation in the United Kingdom: 23 Chesham Street, London, SW1. Tel. SLOane 0456.

Fashion in Footwear Exhibition.—Mon., 3 Oct., to Fri., 7 Oct., at the Washington Hotel, 6-7 Curzon Street, London, W1. Open to the trade only. Organised by Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Higher Management, Course for.—Mon., 3 Oct., to Fri., 14 Oct.; and Mon., 31 Oct., to Fri., 4 Nov., at Dunford College, near Midhurst, Sussex. Inquiries should be made to offices of Associated Industrial Consultants Ltd., or to the AIC College of Management, 54-58 Uxbridge Road, London, W5. Tel. EALing 4567.

Photography, International Exhibition of (commemorating the hundredth anniversary of the Photographic Society).—Sat., 15 Oct., to Sat., 5 Nov., at the Laing Municipal Art Gallery, Newcastle upon Tyne. Apply to Mr. W. Warburton Pope, 9 Kimberley Gardens, Newcastle upon Tyne.

Technology of Plastics Processing, International Congress on.—Mon., 17 Oct., to Wed., 19 Oct., in the Koninklijk Instituut voor de Tropen, 63 Mauritskade, Amsterdam, Holland. Congress offices: N.V.'t Raedthuys, 5 Tesselschadestraat, Amsterdam W, Netherlands.

Engineering Display, 13th.—Tues., 18 Oct., to Thurs., 20 Oct., at the Royal Horticultural Society's New Hall, Greycoat Street, London, SW1. Organised by the Engineering Industries Association, 9 Seymour Street, Portman Square, London, W1. Tel. WELbeck 2241.

Plastics Fair and Exhibition, Second International ("macroPlastic").—Wed., 19 Oct., to Wed., 26 Oct., at the Croeselaanterrein, Utrecht, Netherlands. Apply to the fair secretariat: N.V.'t Raedthuys, 5 Tesselschadestraat, Amsterdam W, Netherlands.

Children's and Teenage Fashions, Third Presentation of.—Mon., 31 Oct., to Thurs., 3 Nov., at Celanese House, 22 Hanover Square, London, W1. Apply to the Teenage Infants' and Girls' Fair Organisation, 92 New Cavendish Street, Portland Place, London, W1. Tel. LANgham 3353.

Fresh Food Packaging Exhibition (The International Prepackaging Exhibition).—Tues., 1 Nov., to Fri., 4 Nov., at the Alexandra Palace, London, N22. Apply to Brook's Publicity Services, 6 London Street, Paddington, London, W2. Tel.: PADdington 6672.

Sports Trade Fair, British.—Mon., 7 Nov., to Thurs., 10 Nov., at Berner's Hotel, London, W1. Organised by the Federation of British Manufacturers of Sports and Games Ltd., Panton House, 25 Haymarket, London, SW1. Tel. WHItehall 5845.

"Evening News" Do-It-Yourself and Hobbies Exhibition.—Tues., 8 Nov., to Sat., 19 Nov., at the City Hall, Manchester. Organised by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester 3. Tel. Deansgate 6363.

Photographic and Television Exhibition, Industrial (Second).—Mon., 21 Nov., to Fri., 25 Nov., at the Royal Albert Hall, Kensington Gore, London, SW7. Organised by Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Corrosion and Metal Finishing Exhibition.—Tues., 29 Nov., to Fri., 2 Dec., at Olympia, London, W14. Organised by *Corrosion Technology*, Leonard Hill House, 9 Eden Street, London, NW1. Tel. EUSton 5911. (Change of title of the exhibition.)

Caravan Exhibition, Second International.—Wed., 30 Nov., to Tues., 6 Dec., at Olympia, London, W14. Apply to the organiser, Caravan Exhibition, *News Chronicle*, Bouverie Street, London, EC4. Tel. FLEet Street 5000.

Smithfield Show and Agricultural Machinery Exhibition.—Mon., 5 Dec., to Fri., 9 Dec., at Earl's Court, London, SW5. Apply to the secretary, Smithfield Show Joint Committee, c/o Society of Motor Manufacturers and Traders, Forbes House, Halkin Street, London, SW1. Tel. BELgravia 6611.

Wholesale Buyers' Gift Fair, Second.—Mon., 12 Dec., to Thurs., 15 Dec., at Mount Royal Hotel, Marble Arch, London, W1. Organised by Trade Promotion Services Ltd., St. Dunstan's House, Carey Lane, London, EC1. Tel. MONarch 0871.

Meetings and Papers

Association of Supervising Electrical Engineers

LONDON
"The Work of the National Inspection Council for Electrical Installation Contracting," by H. C. Breeze. North London Branch. Wood Green Civic Centre, Town Hall, Wood Green, N22. Wed., 6 July, 8 p.m.

MANCHESTER
Film Display. Manchester Branch. Engineers' Club, Albert Square, Manchester. Wed., 6 July, 7.15 p.m.

PRESTON
"Connectors and Crimped Joints": Discussion. Preston Branch. RAFA Club, East View, Preston. Wed., 6 July, 7.30 p.m.

Institute of Physics

LONDON
Annual General Meeting. Tues., 5 July, 5 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 3927)
Institute of Physics, 47 Belgrave Square, London, SW1. (BELgravia 6111)

Self-Supporting Scaffold for Capitol

A system of self-supporting scaffolding has recently been erected around the cast iron dome of the Capitol Building in Washington, D.C.

After a century of exposure to the weather it was necessary to inspect and clean the dome, but the ability of the dome and its foundations to withstand additional loading was uncertain so the architect for the Capitol specified that during the work no additional loading should be placed on the dome.

The solution was found by engineers of the Universal Manufacturing Corporation who designed the scaffolding to comply with this requirement.

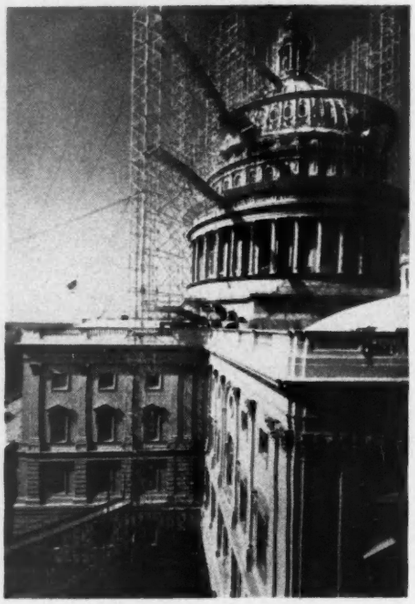
Four scaffolding towers were erected at equidistant points around the circumference of the dome. From high up on each of these towers truss arms of tubular scaffolding ran out to the tholus, the cupola-like structure on the top of the dome. To resist the loading on the cantilever arms steel cables ran from the scaffolding at approximately dome springing level to the top of the towers.

Suspended from these trusses was a scaffold system which completely enclosed the dome and allowed access to any point for cleaning and repair. In all more than 20,000 scaffolding components and 10,000 ft of steel cable were used for the structure.

Cleaning of the 4,450 ton cast-iron dome was done by sand blasting. The large quantities of sand and other materials required were brought up by a hoist installed in a scaffolding tower from which access ramps led to the various levels around the dome. Air was provided by several large compressors at ground level. From the compressors the air was conveyed by 6 in diameter vertical rising mains and fed to the various points of work by small diameter distribution pipes.

Inspection and decoration of the interior of the dome above the rotunda was also necessary. A tower scaffold was used which carried a rolling scaffold with platforms at various levels to give access to the whole of the dome surface.

Because of the constant stream of tourists to the building, all the scaffold materials were brought in at night between 5.30 p.m. and 9 a.m. in the morning.



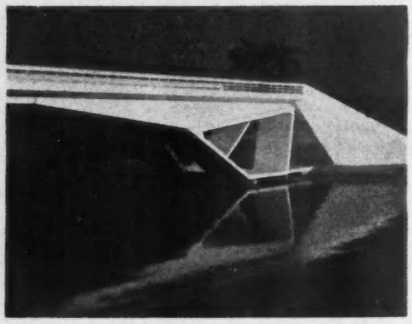
Self-supporting scaffolding in place around the Capitol Dome in Washington.

Easing the Erection of Precast Bridge Girders

An elegant solution to erection problems has been evolved by Ove Arup and Partners of London in their design for a proposed bridge over the Ankobra River in Ghana. The accompanying illustrations are of a model of the bridge that was exhibited at the recent Conversazione of the Institution of Civil Engineers. The bridge is part of a road scheme for the coastal area of Ghana and has a single clear span of 275 ft. Difficulties of construction under condition met overseas have been closely examined in the preparation of the design.

The bridge super structure consists of a suspended span carried by double cantilevers supported on "cradles" and counterbalanced by concrete-filled abutments. The cantilevers on both sides are built up from three beams, each 145 ft long and 8 ft 8 in wide, the depth tapering from 10 ft 0 in at the mid-point to 3 ft 6 in at the ends. The triangular profile of the cantilever, which contributes both to the line of the bridge and will ease erection, is clearly seen in the lower illustration. To eliminate scaffolding from the river course, the cantilevers will be cast as open boxes with transverse webs in a retracted position above the abutments. After curing they will be "launched" down the sloping top of the cradle to their final position. To ease launching the cantilevers will be supported by sliding pads on rails that are incorporated in upstand ribs of the cradle slab. With the cantilevers in their final positions, post-tensioned holding cables will be tied back into the abutments.

The Ankobra River Bridge to be built in Ghana.



The "cradle," abutment and the cantilevers.

The cradles and the abutment wing walls are of reinforced concrete cast *in situ* on formwork supported from the caps of pile groups driven into the soft sand of the river bed. The suspended mid-span section consists of three simply supported precast box beams 80 ft long and 3 ft 6 in deep which will be lowered into position from a temporary construction bridge previously erected between the tips of the cantilevers. The beams will be tied together transversely by an *in situ* road slab. The walkways, precast in 5 ft lengths, will cantilever out from the sides of the main structure.

Proximity to the sea governed the choice of concrete as the structural material, with the object of little maintenance being required.

Timber Wharf Shed

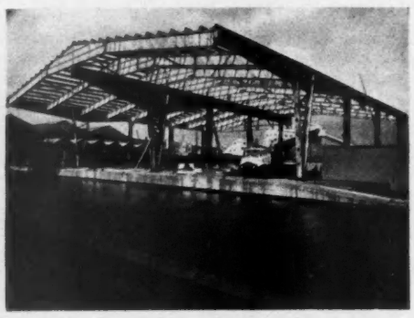
The timber framework shown in the illustration is for a storage shed at Sayes Wharf on the Grand Surrey Canal.

The shed, which is the property of Joseph Sandell and Company Limited, spans 120 ft. Twelve columns—four along each side and four down the middle—carry the ten trusses that have been used in the roof. The shed is 100 ft long, with an extra 35 ft long canopy that overhangs the canal by 20 ft to permit freight handling to go on unhindered by the weather.

The roof trusses have been made to HB patents by Beves (Structures) Limited of Shoreham, Sussex, who designed and erected the shed. Beves are the sole licensees in this country for the HB system of timber construction which originated in Sweden. Basic to the system is the HB beam which is of I section and built up from small sizes of timber to produce the required section and load-carrying capacity. The web consists of two layers of boards laid diagonally to the length of the beam, at right angles to each other, and of the full depth of the beam, out-to-out of the flanges. The flanges are of glued laminated boards placed vertically in the beam so that their widths form the depth of the flange. To make the beam, each flange is built up in two halves, one on each side of the web; the two parts of the flange and the web are then through-nailed to a predetermined pattern. The nails are of a section peculiar to the system and are used in sufficient numbers to transmit all the stresses. For deep beams, stiffeners are also used to restrain buckling.

The trusses and posts for the Sayes Wharf shed were all manufactured at Shoreham, brought to the site by road and erected by crane. All the members were treated with Protim preservative.

The cost of the structure was not the lowest possible in first costs, but was selected because timber structures require so little maintenance.



Timber trusses for a roof having a plan area of 135 ft by 120 ft. They are built up from small sizes of timber.

Low Cost Roads Overseas

At Kampala, in Uganda, a small group of engineers from the Esso Research centre at Abingdon, Berkshire, has been supervising the laying of a series of test road surfaces using a non-hardening bituminous material.

This comparatively new and economical road-making material, which has been successfully used in Sweden for three years, has a unique self-sealing property that has been used to advantage on roads liable to damage by frost, ice and rain. The purpose of the experiments is to discover if the techniques could be adapted to the tropical conditions found in so many of the underdeveloped areas.

Results are not expected for a year or two.

Traffic Pavements: Code of Practice

The latest of the civil engineering codes of practice, Traffic Bearing Structures — Pavings, CP 2006 : 1960, has been prepared by a committee convened by the Institution of Civil Engineers on behalf of the council for Codes of Practices.

CP 2006 is divided into five parts: design and construction of foundations; concrete roads and airfields; surfacings other than concrete; footways, cycle tracks and verges; and surface water drainage. The code contains, in addition to the recommendations, numerous tables and figures to assist design and construction.

An especial effort has been made to gather together and to present in a convenient form the principles and factors governing the calculation of pavement thicknesses and the construction of foundations from widely differing materials and under varying conditions. Mechanical methods of placing and consolidating materials are dealt with in considerable detail.

The code is at present in its draft form and it is to be expected that it will be revised as experience shows up improvements.

Copies of the code can be bought from the British Standards Institution, 2 Park Street, London, W1 (30*s*, postage extra for non-members).

Nairobi's Water Supply

Nairobi, capital of Kenya, is planning to spend £9½ million over the next 15 years to extend the city's water supplies. The population is now 250,000 and is expected to double by 1975.

New sources of supply are to be found and developed to meet a consumption that is expected to rise from today's figure of 9·8 million gallons per day to 25 million by 1975 and to 30 million gpd by 1980. Present sources of supply are at the Ruiru dam (18 miles) and the Sasumua dam (40 miles); the first stage of the new works proposes a heightening of the Sasumua dam and diversion of a river to give a bigger reservoir there. More storage for treated water is also to be built within the city area.

The consulting engineer to the council, who has prepared the scheme for capital works until 1975, is Mr. Hugh Dixon of Howard Humphreys and Sons.

Fire Resistance of Structural Components

The fire resistance of a long range of proprietary structural elements, as measured by the Joint Fire Research Organisation at their Boreham Wood laboratory, is given in a new publication *Sponsored Fire Resistance Tests on Structural Elements*, published for the Department of Scientific and Industrial Research by HMSO (7*s* 6*d*, by post 8*s*).

The book is made up of data sheets compiled over several years of testing proprietary materials and forms of construction. The test reports are presented under the following headings: load-bearing walls, non-loadbearing walls, simply supported floors, restrained floors, suspended ceilings, concrete columns, steel columns and glazing. It is proposed to issue supplementary data sheets at intervals. The present publication gives full details of the materials and methods used in constructing the test speciments, together with the name of the manufacturer concerned, so that any component incorporated in a design can be reproduced as closely as possible. The grade of fire resistance found is quoted in every case.

Sweetening Polluted Water

A simple remedy for stagnant and polluted water has been found in compressed air. In one particular lake in Sweden, where the oxygen content had dropped to nearly zero, compressed air introduced into the water through a perforated plastics hose laid across the lake bed enabled the dissolved oxygen to be increased to 57 per cent within three weeks, and for plant life to begin to re-establish itself. When the treatment was begun there was a difference of 12° C between the surface and the water at the bottom. This difference also disappeared in the three weeks. A small 8 h.p. compressor supplied the air.

It should be noted that the water is not oxygenated by the compressed air itself, but by the waves created by the pumping action of the water as it forces its way to the surface. The waves pick up oxygen from the atmosphere. One hazard to be avoided is the release of hydrogen sulphide which may be present in the lower layers of the stagnant water.

The method was initially worked out on a small lake called Långsjön which had gone sour and the use of compressed air to relieve the situation was put forward by Mr. Leif Bruneau who asked for help from Atlas Copco, the compressed air engineers with headquarters in Stockholm. So successful has the method proved that it is to be employed in other similarly soured lakes. Mr. Bruneau says that, though the case for compressed air should not be overstated, the method should be considered as useful in solving acute problems of pollution, especially if it precedes the installation of conventional purification plant.

Administration Costs of Public Works Overseas

The cost of a public works department overseas varies widely with the total work to be done, the type of project to be carried through, its geographical distribution and the size of the territory, as well as many other factors. Sir Reginald Taylor, C.M.G., M.I.C.E., engineer-in-chief of the Crown Agents, in concluding his paper to the Conference on Civil Engineering Problems Overseas, hazarded the figure that, under average conditions, a complement of professional officers (comprising engineers, architects and quantity surveyors) was needed at the rate of one officer for every £80,000 to £100,000 of work to be done, including design, construction, maintenance, supervision and administrative duties.

The conference, the seventh in the series, was held at the Institution of Civil Engineers and Sir Reginald gave the first paper of the meeting. The title of his paper was "The Organisation of a Public Works Department." He gave a suggested organisation, for the average conditions as they are today, of a Ministry and a Department concerned almost entirely in works production and operation. Especial emphasis was put on the aspects of finance, administration and ancillary services, rather than on the technical divisions, because that was where the works departments "had come under heavy fire."

For underdeveloped territories, where the expenditure on capital works was relatively small, Sir Reginald thought that an all-comprehensive Ministry of Works was advisable, rather than that the individual ministries should each be responsible for the work that followed from their policy decisions. Such a Ministry of Works would act, in a sense, as a consultant and contractual agent for the other ministries requiring work to be done.

He listed the advantages of such a department as follows:—

Technical advice came from one source and the assessment of relative merits would be done only by the one technical head of the Ministry of Works.

Limited expert staff could be employed on similar problems whatever the type of work involved.

Within the one department services such as plant and equipment, vehicles and stores, common to all the diverse activities of the department, could be provided.

Standardisation of plant and equipment was easier to achieve.

The disadvantages were those of the totality of the work getting too much for one management to control and that the diversity of the work might become too wide for the head of the department to cope with; this could be met by the break-up of the department under separate specialist technical heads and by the judicious use of consultants.

Granolithic Toppings for Concrete Floors

The Cement and Concrete Association have compiled and issued a booklet entitled *Specification for Granolithic Floor Toppings Laid on in-situ Concrete*.

Two methods of construction of in-situ floors not less than 4 in thick are considered in the specification. They are the monolithic floor, in which the topping is laid within three hours of the base concrete, and the "separate" where the topping is laid any time after the base has begun to harden.

The booklet's recommendations are based on a study of the causes of failure in granolithic toppings. To broaden the value of the clauses of the specification, explanatory notes or amplifications follow many of the clauses.

Among the points covered are the selection of materials, mix, spreading and compaction of the concrete, laying of the topping and curing. Other clauses also refer to the setting and removal of formwork.

A safeguard that may save someone getting into difficulties while trying to do a good job better is contained in a note which observes that "the use of thick toppings, about 1 in or more, in monolithic construction is liable to result in curling of the whole slab."

Copies are available free on request from the Cement and Concrete Association, 52 Grosvenor Gardens, London, SW1.

Reducing Noise on Contract Sites

Reconstruction of city centres, involving demolition and building work on an increasing scale, is necessarily accompanied by noise from contractors' plant, much of it being unavoidable if full power of the equipment and tools is to be exploited.

That contractors are aware of the problem that such noise creates, and are continually seeking to minimise it, is illustrated by a recent example from a London site where the builders Trollope and Colls have cut down compressor noise by over 50 per cent by using an electrically driven Consolidated Pneumatic "Power Vane" compressor instead of the more usual diesel driven machine. The noise reduction achieved is said to be due not only to the elimination of pistons and valves in the power pack, but also to the quiet operation of rotary vane compressors.

New Investment in the Common Market

Inducements and obstacles to investment within the European Common Market grow in importance. The ECM Six seem to be seeking American rather than British capital.

NOTHING has filled the mind of British industry with more foreboding during the last year or so than the growth of American investment in the European Common Market. The actual figures available so far have not been particularly ominous and, in any case, the picture has been clouded by the effect of the recent recession in the United States on that country's overseas investment. Nevertheless, the impression persists and there is plenty of evidence to support it, that the member countries of the European Common Market have made organised and successful efforts to attract private American capital.

Those who have this impression have been able to point out that there is a genuinely political, federal idea behind the Treaty of Rome, and that the economic division of labour between member countries has already begun. They have been able to show that the area of the Common Market has a large population and possesses tremendous growth potentialities. The McGraw-Hill department of economics has recently produced a survey which suggests that, by this year, manufacturing concerns in the United States will be spending 47 per cent of their foreign outlays in western Europe compared with 40 per cent in 1957. A good deal of this change represents an increase in the attractiveness of western Continental Europe and not just an urge to invest in the United Kingdom.

It is also significant that, while member countries of the Common Market have actively sought American capital, they have done little in an organised way to attract funds from this country. All six countries in the Common Market area have concessions and inducements which they can offer to foreign capital, but there have been few campaigns by them in this country on the " come to the Continent " theme.

TRADE FOLLOWED THE FLAG

Trade used to follow the flag according to the dictum of 50 and more years ago. Today, the reverse may be the case. Signs are growing that, while this country hesitates politically at the fringe of the Common Market, wondering whether it should seek a formula for membership, trade is leading the way. The politicians may, of course, be waiting for industry and commerce to give a lead and create a spontaneous demand to integrate with western Europe. Certainly a number of companies have begun to extend their interests within the Common Market area by setting up sales offices, acquiring subsidiaries and entering into new trading arrangements with concerns within the area.

Now the Association of British Chambers of Commerce have published a booklet called *Aids to Investment in the European Economic Community* (price 2*s* 6*d*) which contains the pointed comment that, in the short term, such investment ensures a foothold in the Common Market while negotiations between the European Economic Community and the Free Trade Association continue. This booklet is a guide to the concessions and the liabilities which await foreign investment in each of the Common Market's six countries.

In the case of Belgium, two recently-enacted laws give substantial advantages to any person or company investing in industrial assets in that country. There are several forms of Government aid available. Interest rebates taking the form of a subsidy effectively reduce interest charges, amounting usually to 2 per cent but occasionally going as high as 4 per cent. The Belgian State can also guarantee security to lenders up to a total amount of £43 million. The Belgian Government can also acquire or erect buildings which they can sell or lease, subject to the company concerned contracting to use the building for industrial purposes. The State may also make interest-free loans for research, the development of new products and prototypes, and for new industrial purposes. Property tax exemption during the first five years' occupation is obtainable on buildings.

In the Federal German Republic, there are no special incentives to foreign investors but, on the other hand, there are no discriminatory practices. There are no prescribed maximum ratios about foreign-to-local capital in undertakings or regulations about the form in which it must be invested. Special concessions are, however, available outside the Ruhr, such as in parts of lower Saxony and south Germany. There is a double-taxation agreement between the United Kingdom and the Federal Republic.

COMPLICATIONS IN FRANCE

The most complicated situation is found in France. The French Government much desires foreign capital to be attracted to areas of high unemployment. Substantial concessions are available for enterprises set up on what are called the *zones critiques*, but they will apply only until January, 1961. It is anticipated that, after that date, the zones will be abolished and the concessions reduced. One of the large-scale advantages of setting up industry in France is the access which it gives economically to the rest of the French Community overseas. On the other hand, there are certain general drawbacks. There remain the restrictions on the transfer of profits and on imports. Administrative delays are also apt to occur which have to be smoothed over by personal contact. Moreover, it is advisable to appoint a Frenchman as chairman and managing director (one person) in order to avoid permit complications.

The main advantages offered in the *zones critiques* are Government loans at reduced rates, an equipment bonus equal to a 20 per cent gift on the loan already mentioned, the waiving of local rates for five years, and financial assistance in the way of help with social charges during the initial period of assembling the labour force.

Perhaps the most formidable exercise, however, is grasping the scope of French tax levies and rebates.

The sub-headings and the rates of taxation can be found in the booklet itself. There is a subscription tax on new capital borrowings and new cash brought in as capital. There is a conveyancing tax on sales of goodwill, finished stocks and buildings. An ordinary companies' profits tax is also levied. Then comes distributions tax on dividends and one on the capitalisation of reserves. There is a tax on the value added to a product in the manufacturing process and a service tax as distinct from the one levied on the sale of goods.

Social services taxes include a pay roll tax, an apprenticeship tax, family allowance contributions payable by the employer, employers' social security contribution, and a similar contribution for industrial injury and superannuation tax. Further, there is a buildings contribution, calculated on the wages bill, for the erection of employees' houses.

To end the list, there are two types of tax with variable rates: the business tax, which is based on the annual rental value of buildings and plant and the number of persons employed; and a property tax, based on the annual value of buildings and land used by the business.

In Italy, foreign investment is regulated by a law of 1956. The flow of capital into Italy since that time has steadily increased. Funds can be invested freely in any industry in Italy, except in shipping, aviation, insurance and credit; in which cases, special permission is required. No other form of discrimination, as between foreigners and Italians, is practised.

Foreign investments may be implemented by transferring foreign exchange, by importing machinery and by the licensing of patents. In the case of productive enterprises (which would, of course, include all engineering companies), foreigners may transfer earnings abroad without limitation. A company formed in Italy with foreign capital may borrow on the Italian capital market and may issue bonds. Some import controls still remain but the trend is towards liberalisation.

There are two types of direct tax: income tax and corporation tax. Income tax applies to any income not derived from land or buildings. Corporation tax is paid by companies on their paid-up capital, reserves and undistributed profits. There are also certain indirect taxes, including a registration tax. Special reliefs are obtained by enterprises establishing themselves in southern Italy.

In the Netherlands, there are no special concessions to foreign capital and the country, by tradition, is liberal in these matters. In deciding whether to establish a production unit in Holland the main consideration must usually be the export potential. The home market in the Netherlands is rarely large enough to support a high enough level of output. Of all the countries in the Common Market, the Netherlands has perhaps had most experience in launching out into neighbouring markets. Before the European Economic Community came into existence, the Netherlands was the low-cost area of the Benelux group and for ten years has gained experience in competing in comparatively higher-cost areas, notably in Belgium.

LUXEMBURG'S SUCCESS

A permit is necessary to set up a company in Luxemburg. Taxation there is not complicated by, say, French standards and, during the last few years, the country has already attracted a large amount of foreign capital having regard to its relatively small size.

It is apparent from the considerable differences which exist between these countries, so far as foreign investment is concerned, that any decision as to where to set up in the Common Market area must be a matter of intricate calculation. Calais is near, facilities are good and labour has a good record in industrial relations. French administration, however, is complicated, and not only in respect of taxation matters. Southern Italy is close to that part of the Mediterranean area which may secure a large increase in its living standards during the next generation. There are special incentives, but the increase is still a long way away. Markets have to be studied and the degree of integration already achieved among companies within the various industries since the coming of the Common Market must be assessed.

The climate of investment for foreign companies in continental Europe is indeed as much affected by the general attitude of industry there towards collaboration as it is by special aids, obstacles and tax provisions set up by national governments. There are signs that continental industrialists are more actively seeking the mutual exploitation of patents with foreigners and are prepared to explore working agreements. These may be substitutes for, or in addition to, investment opportunities, depending on the circumstances. American industry is already active in this direction as well.

Finally, the scope for sound investment calls for a thorough examination of the changing structure of European industry. The coming of the Common Market has already brought a measure of rationalisation across national frontiers in certain industries and more may come.

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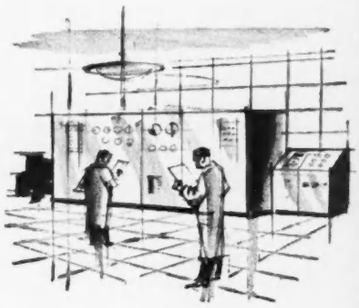

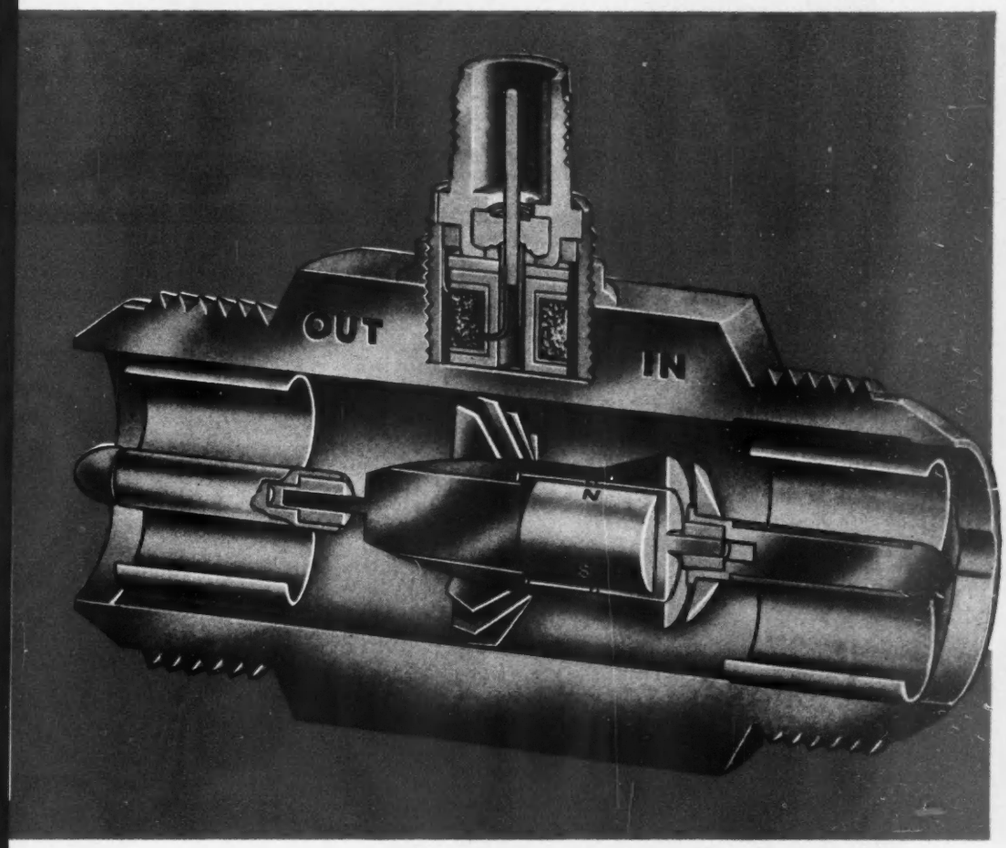

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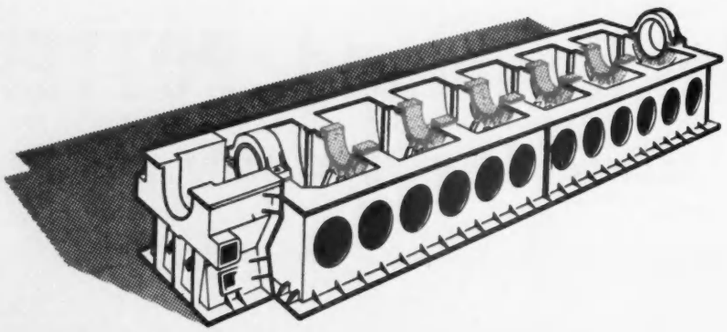

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Dr. Pope to Lead New Hawker Research Unit

HAWKER Siddeley Industries are to open a new research centre, providing basic research and development facilities, at Stockport.

The centre is to be directed by Dr. Joseph Albert Pope who for four years past has been responsible, as professor of civil and mechanical engineering at Nottingham University, for planning the new laboratories of the faculty for applied science at Nottingham.

Dr. Pope was a Boulton and Paul apprentice who began his technical education at Norwich Technical College. On a Whitworth scholarship he attended King's College, London, obtaining a First Class Honours degree in mechanical engineering.

Gaining his Ph.D. and later his D.Sc. at Queen's University, Belfast, he went to Nottingham University in 1949.

The author of many technical papers, Dr. Pope was the senior author of a paper on metal fatigue, "Limited Life Design," which appeared in ENGINEERING (vol. 184, '57, pp. 236-241 and pp. 275-278, 23 and 30 August).

He has also written on the deformation of metals due to dynamic loading, the fatigue of metals, temperature stresses, the failure of diesel engine components, and heat transfer in turbine blades.

Hawker Siddeley's new research centre will provide facilities for the heavy diesel engine companies, Mirrlees, Bickerton and Day and National Gas and Oil Engine. More than £250,000 will be spent on equipping the centre with laboratory and testing equipment. The research unit will cover an area of 25,000 sq. ft.

Company Responsibilities in Dip. Tech. Studies

The optimists who declined to entertain doubts about the success of the Diploma of Technology when it was first introduced have been proved right.

The annual report of the National Council for Technological Awards sets out 95 recognised courses at 23 colleges. Four thousand students have enrolled for courses leading to the award; 84 of them women. And the expansion is continuing.

Just over a year ago the total number enrolled in the first year of the course was 1,171. The number now in the first year of their Diploma studies is 1,558. The majority of those working on the courses are doing it by the sandwich method, in which spells at the works alternate with periods in college.

Some interesting cases have come up where students, as required by the conditions for the award of the Dip. Tech., are participating in a "substantial" research project. Equipment all the way up to the computer possessed by one college has been used. Some of the advanced work is important enough for arrangements to be in hand for its publication.

An important step forward last year was the establishment of the College of Technologists. Entry into the select band of members of the college is equivalent to the Ph.D. of a university. Five of the nine applicants who have so far registered have been entered as candidates for membership and three are still under consideration.

Ph.D. Equivalent

The National Council has also published a memorandum on the industrial training of students in courses leading to the diploma. It is particularly interesting for its information on the responsibilities of the firm providing the industrial training. When a firm applies to send students on a course for the diploma or agrees to provide industrial training for college based students, the Council takes this to mean that:

The firm is willing to work in the framework of the Council's requirements and to collaborate with the college concerned in devising an acceptable scheme for industrial training or in modifying their existing scheme to meet the Council's needs.

The firm will make adequate arrangements for supervising the student through his industrial training.

At the end of the course the firm will be responsible for assessing the extent to which the student has benefited from his industrial training and for certifying that he has satisfactorily completed his training.

The firm accepts the Council's right to examine the details of the company's industrial training scheme.

Finally, if problems arise which cannot be solved locally the firm and the college may jointly approach the Council for guidance or a ruling.

Among the many colleges who have put a large part of their effort behind Dip. Tech. courses it would be unfair to make comparisons. To mention only one, the Northampton College of Advanced Technology, in Clerkenwell, London, has Dip. Tech.(Eng.) courses in aeronautical, chemical, electrical, mechanical and production engineering. It also has full time and sandwich courses in industrial chemistry leading to the Dip. Tech.

Many of the great names of British engineering are among those providing industrial training for students who won diplomas during the year. The nuclear industry and its heavy electrical suppliers, aircraft, steel and chemical interests were all among those who provided facilities. The list of these companies includes those who make equipment that goes into ships but not a single shipbuilding concern.

CEGB Awards 24 Scholarships

Three girls and 21 boys have been granted scholarships at British universities by the Central Electricity Generating Board.

From grammar schools all over the country the CEGB has selected the 24 from some 300 applicants to study engineering or scientific subjects before joining the Board's staff. During their university courses the students will spend certain of the vacations on practical training in the industry.

Most of them will go into research after graduating.

For Oxford and Cambridge colleges the scholarships are worth £450 a year. At other universities they are worth £400. Seventeen of the scholarship winners are to study at either Oxford or Cambridge.

Keeping Professors in the AEI Picture

Sir Willis Jackson, president of the Institution of Electrical Engineers, will have more than 30 professors of electrical engineering in his audience at Rugby next month when he lectures on "The Relation between the Industry and the Universities."

The occasion will be the summer school of Associated Electrical Industries (Rugby), the fourth since the war. The professors, drawn from universities and technical colleges all round Britain, with three from overseas, will hear lectures from AEI's engineers, some of them their own former students, on the most recent developments in electrical and electronic engineering.

Visits to various AEI works and laboratories, and a new research laboratory at Rugby, have been arranged.

Authority for National Technical Staff College

Three years after the suggestion from the Willis Jackson committee that there should be a technical staff college, authority has been given for its formation.

£105,000 has been subscribed by 100 companies, following the appeal earlier this year. The idea from the Willis Jackson committee was that senior teachers from technical and commercial colleges should be able to exchange ideas and experiences with industrial management in a staff college.

The Ministry of Education made it known at the time Sir Alexander Fleck, the former ICI chairman, launched the appeal, that if enough money was put up it would make a substantial annual contribution towards the running costs.

The representation on the board of governors, of which Sir Alexander is to be the first chairman, is extremely wide. Industrialists, representatives of the local authorities and the technical colleges, Scotland, and the universities, are all to be included.

Most important of all the problems raised by the new technical staff college will be the selection of the best possible staff. Unless some special dispensation is applied to the salary levels, such as using the university teachers' scales, it is not easy to assume that the attraction to move to the staff college from industry will be very great.

If the guiding hand of Sir Alexander Fleck and the varied board of governors is accepted as likely to be able to handle those difficulties, then the only other problem is that of encouraging the local authorities to release their ablest teachers to attend the courses.

British Women Engineers Going to Russia

Two women engineers, one of them the first woman member of the Society of Instrument Technology, are to visit the USSR.

They have been awarded exhibitions by the Caroline Haslett Memorial Trust and they are to study the training, employment and prospects of women in engineering in Russia.

Miss Lesley Souter, one of the two "exhibitioners," is one of an Elgin, Scotland, family of engineers. She studied electrical engineering at Glasgow's Royal Technical College, and took a first class B.Sc. with honours. She has worked in development and research at the General Electric Company, Mullards, and the Radiation Group Laboratories. She is now the leader of the magnetic materials section of the Associated Electrical Industries' Harlow laboratory.

Miss Rosina Winslade is senior sales engineer of Research and Control Instruments Limited. The first woman to join the Society of Instrument Technology, she is also a council member of the Women's Engineering Society.

Women engineers are understood to occupy higher posts in Russian industry, and a greater proportion of them than in the United Kingdom. Since there is a well known need in Britain for more engineers and scientists of many kinds, the visit of Miss Winslade and Miss Lesley will, the Trust is hoping, provide valuable information and help to encourage the advance of women engineers in this country.

Miss Winslade is a good example of making progress in the engineering profession the hard way. She left school at 14 and then studied electronics part-time at the South East Essex Technical College, at the Regent Street and Northampton Polytechnics.

Influential Backers for European Talks Motion

With the Labour Party in disarray the criticism of Government policy has to come from its own supporters. More particularly from those who want to move in some direction that those in office either do not care for or are plainly rather half hearted about.

What exactly Government policy is about the increasingly powerful Six, the European Common Market, it is not easy to set down in brief. Some right-wing critics openly assert that there is nothing at all behind the assumption that since there is a problem there must, it is hoped, be a policy to deal with it.

On the face of it the entire Conservative leadership of the backbenchers' committee on foreign affairs wants something done to heal the economic rift. All the committee's officers have signed a motion published in the Commons asking the Government to make firm proposals for negotiations with the Common Market powers.

The chairman, the two vice-chairmen and the secretary, as well as 12 other Conservative members have all put down their signatures. It is worth noting that among these 12 are the secretaries of the backbenchers' agricultural and horticultural committees.

The motion wants the Government, without delay, to consult our partners in the European Free Trade Association and the Commonwealth and "to put forward firm proposals for subsequent negotiations with the Six."

No doubt it would be possible to expound in the subsequent parliamentary debate the ideas that the motion's supporters would like the Government's representatives to negotiate towards in a meeting, if it were arranged, with Professor Hallstein's colleagues. But without this clarification, the motion makes this position no clearer, though perhaps a little more urgent.

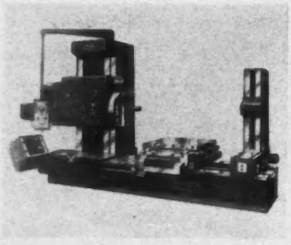
International Machine Tool Exhibition, London 25 June—8 July

In his speech at the opening luncheon for the London International Machine Tool Exhibition, Mr. Reginald Maudling, the President of the Board of Trade, drew attention to the fact that the increase of machine tool imports during the first quarter of the year by 20 per cent was more than balanced by an increase in exports during the same period of 43 per cent. This he said was what was needed and he wished that other industries could show the same sort of figures.

In the last two issues there have been special articles dealing with manufacturing techniques of the future and with machine elements and methods of control. To obtain power, many tools incorporate Ward Leonard sets for conversion, but recent developments have produced control units using completely static elements that are both smaller and more efficient for the purpose. In this issue are articles dealing with problems of rigidity and high speed machining, as well as a continuation of these descriptions of the exhibits.

HORIZONTAL BORER

3½ in Spindle



REPRESENTATIVE of a redesigned range of horizontal boring machines is the RHT3 which has a 3½ in diameter spindle.

The full range has models with spindles from 2½ to 6 in diameter and facing head capacities from 30 in to 72 in diameter. The RHT3 machine has spindle traverse of 24 in and a maximum spindle height above the revolving table of 37 in. Above the sliding table the maximum height is 41½ in. The facing head will work up to 30 in diameter.

The sliding table measures 48 in by 30 in and the revolving table 36 in square. Longitudinal traverse is 42 in and cross 37 in. The distance from facing slide to boring stay is 87 in. Feeds to the facing slide are infinitely variable over the ranges from 0·05 to 1·5 in per minute (fine) and 0·66 to 20 in per minute (coarse). There are 27 speeds for the traversing spindle, from 7 to 1,000 r.p.m. in the standard machine with an alternative up to 1,250 r.p.m. The facing head has 18 speeds from 7 to 210 r.p.m. Power is supplied by a 15 h.p. motor.

All the machines can be fitted with automatic coordinate positioning using either tape or dials. The actual dimension is presented in decimal form. The position of the table is measured by a linear optical scale which alters the phase of a sine wave when the table moves. The system can be set in increments of 0·0005 in. Position accuracy is better than 0·00025 in for any position and repeat accuracy better than 0·0002 in. *George Richards and Company Limited, Broadheath, Altrincham, Cheshire.*

THREADING MACHINE

For Maintenance Work

THE Maiden-Lansta threading machine is designed primarily for maintenence work.

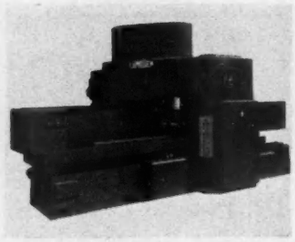
It has a stationary tangential diehead giving it a capacity for tubes in the size range from ¼ in to 2 in diameter and bolts in the same range. The fitting of a tangential stationary diehead is unusual in a maintainence machine, but lends itself to the incorporation of cutting-off and tube chamfering mechanisms, both of which are included. A reaming attachment is fitted with the cutting-off equipment and die head to the saddle of the machine.

Speed variation is provided by fitting on the headstock pickoff gears that allow a choice of two spindle speeds, either 19 or 54 r.p.m. The workpiece, which is rotated, is gripped by a three-jaw self centring chuck at the spindle nose.

The machine as shown in the illustration is of the pedestal type with the controls conveniently mounted at the front. The driving motor is mounted above the headstock. Provision is made for a coolant supply to the workpiece. As an alternative the machine can be so mounted as to make a transportable unit for use in the open shop or where it is more convenient to have the machine near the site of the work being done. *Landis Machine-Maiden Limited, Maiden Division, Hyde, Cheshire.*

SURFACE GRINDER

Reciprocating Table



MODEL 71-MLOD is a completely redesigned vertical spindle reciprocating table surface grinding machine.

This machine has a 40 h.p. main motor driving a 20 in diameter segmental grinding wheel and has a table surface of 60 in by 18 in with 11 in of vertical clearance over the whole area. The redesign is towards greater safety, improved operation, and reduced maintenance.

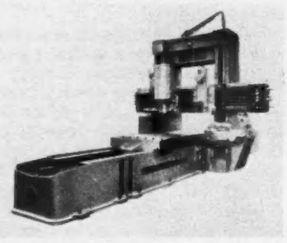
The double columns have been set at an angle for accessibility in loading and unloading, while the drive to the main spindle has been enclosed in the bridge. The drive to the spindle from the motor is by power grip belt.

The bed of the machine has been lengthened to allow complete protection of the ways, and lubrication of the ways is automatic. The hydraulic valve control box has been improved and repositioned for convenient operation. Sliding doors have been fitted to the table guards. The feed to the grinding wheel is hydraulic, the feed box is a new design and the controls and trip mechanisms simplified. Power elevation has been added for quickly raising and lowering the wheel spindle.

Current is fed to the magnetic chuck from busbars fitted beneath the table, and the current rectifier and transformer are mounted in the bed of the machine. Control of the chuck is by push button and the chuck when switched off brings in a demagnetising device for the easier unloading of components. The multi-motor control equipment is built into the machine column with the push-button station convenient to the operator. *Lumsden Machine Tool Company Limited, Hawks Road, Gateshead 8.*

PLANING MACHINE

Double Housing Type



A NEW design of planing machine incorporates a closed loop Ward Leonard drive giving a greatly improved performance over the open loop system.

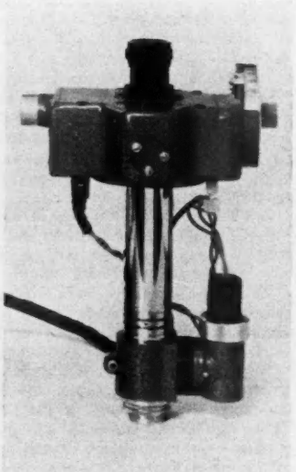
The machine has a table 4 ft wide by 10 ft long and clears 4 ft under the beam. All controls are mounted on the one side with a pendant for the push buttons. The new drive offers increased horsepower at the tool for high speed machining, with the constant torque rating extending up to maximum speed. There is a quicker acceleration to the selected cutting speed and a quicker deceleration at the end of the stroke, both contributing to a shorter time cycle. As the torque is controlled during reversal there is shockless drive to the main transmission. A wider range of speeds extending up to approximately 50 to 1 allows better choice.

Advantage has been taken of the wide speed range to fit a milling head designed to work with feed rates that are available from the low speed range of the driving motor. Of simple design, the head will transmit 20 to 25 h.p., and so achieve rapid metal removal. The head can be mounted on the normal tool box slide of the machine from which it can easily be removed when planing is to be carried out.

The table moves on flat ways and is guided between the inner lips giving an accurate guide with a broad bearing surface. Driving worms and table ways are pump lubricated. The cross rail carries at the far end the feed motor and gearbox driving through magnetic clutches. Within each range the speeds are infinitely variable. *Scottish Machine Tool Corporation Limited, 17 Lynedoch Crescent, Glasgow, C3.*

MICROMETER MICROSCOPE

Photoelectric Operation



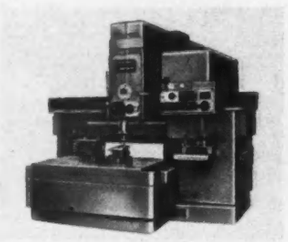
A NEW Hilger and Watts photoelectric microscope has been produced for reading subdivisions of line standards and other linear or circular scales.

It is claimed that the photoelectric operation is quicker and more accurate than the more conventional optical micrometer instrument. It can be used on lines that are between 0·0001 and 0·0015 in thick, the position being indicated on an instrument meter.

Initial setting is by positioning twin setting lines on a graticule symmetrically about the scale division, first optically and then checked by the indicating meter. Subsequent settings on scale lines are then made by rotating the micrometer screw until the meter needle again returns to zero. The distance moved is read from the drum in the usual way. A graduated scale in the eyepiece is used when more than one revolution of the drum is involved. The working distance is 1 in and the magnification × 51. One subdivision at the object plane is 0·00002 in and the accuracy over the total range is ±0·00004 in with repetition to 0·00001 in. *Alfred Herbert Limited, PO Box No. 30, Edgwick Works, Coventry.*

PRODUCTION BORING MACHINE

Punched Card Control



THE Bemag Swartzkopff KBF2 is a production boring machine designed for punched card control of position, speed and feed.

The machine has a bridge type column on which is mounted the longitudinal slide which in turn carries the cross slide. Each slide is a self-contained unit and incorporates precision end measuring rods held in a magazine. These are electrically selected while the movement of the slide is carried out hydraulically. The accuracy approaches that of jig boring.

The longitudinal traverse is 50 in and the cross traverse 30 in. The working area of the table is 63 in by 38 in and the maximum distance between the spindle and the table is 30 in. Vertical adjustment is by four screws using planetary gearing with backlash eliminators under push button control.

Coordinate settings are made by simple punch card programming or by two groups of counter wheels fitted to the front of the machine. Six figure readings are to 0·0001 in. Preselection of the coordinates can be made while the machine is operating. As soon as the spindle is withdrawn from the first hole, pushing two buttons will start the movement to line up for the second.

The machine allows a choice of 18 spindle speeds covering the range from 35 to 1,800 r.p.m., as well as nine boring feeds. In addition there are infinitely variable milling feeds, the spindle being driven by a 5½ h.p. motor. Both longitudinal and cross slide movements are clamped hydraulically when in the working position. *Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2.*

HANDLER

For Press Tool Die Sets

ILLUSTRATED is a device for handling the heavy die sets used with press tools.

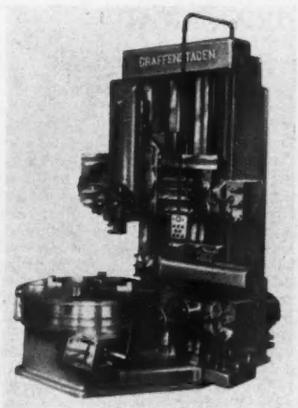
Model 1018 shown (the latest in the series) has a platen area of 17 in by 26 in and will carry a maximum die weight of 3½ cwt. It is mounted on 6 in diameter wheels with hard rubber tyres, the front pair being made to swivel and the rear being fixed. The surface of the lower platen is 30 in above the floor level.

In operation the die is placed on the lower platen and the top one lowered on to it. To open the die, the top platen is clamped to the top section and raised by power from the motor in the body of the handler or by the hand crank. After separation the top section of the die may be revolved through 360°.

The minimum distance between the platens is 4 in and the maximum is 16 in. T-slots are provided for bolting on The upper platen is raised and lowered on screws running inside protective sleeves and a safety rod automatically stops the motor at the end of travel. The single handle can be used to control the turn-over of the upper platen; the start and stop of the lifting motor; and to supply the hand power for lifting without the motor. The motor is rated at ¼ h.p. The maximum die tryout force recommended is 1 ton. The whole unit weighs 525 lb. Other models are available. *Funditor Limited, Woodbridge House, 3 Woodbridge Street, London, EC1.*

VERTICAL BORER

55 in Diameter Table



THE Graffenstaden vertical borer TV142 is a new design in which the carcase forming the column and table bed is in one piece.

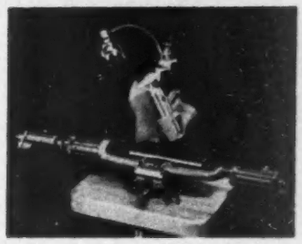
It is claimed that this gives a very rigid and stable machine that does not require deep foundations and will retain its accuracy for many years. The rotary table, which is 55 in diameter, runs on a pressure film of oil and has a maximum load capacity of 4 tons. With a maximum turning diameter of 59¼ in and a clearance under the cross rail of 51¼ in the standard machine can utilise long tooling. The pentagonal turret has a travel of 43¼ in and can be raised 21 in above the lower edge of the cross rail. If required the clearance can be increased to take work pieces up to 55 in in height.

The total rams for both the pentagonal and side head tool holders can be swivelled each way at 45° and 30° respectively and are controlled by natural movement levers.

The main motor is rated at 45 h.p. and is controlled from a pendant panel. There are separate motors for the cross rail and all rapid movements. A clutch is incorporated for smooth starting. A hydraulic copying device may be fitted to either ram, and screwcutting and taper turning attachments can also be supplied. *Acbars Limited, Cecil House, 57a Holborn Viaduct, London, EC1.*

HIGH SPEED MILLER

Up to 45,000 r.p.m.



THE "Precise" milling machine illustrated is a high speed machine for small workpieces.

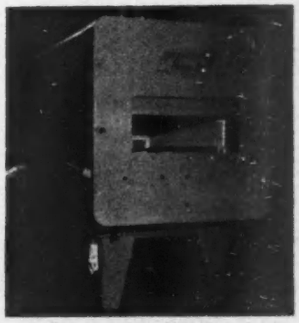
The design is intended to give high rates of production of small parts to a high degree of accuracy. The cutting tools used are of tungsten carbide and can be either mills or grinding wheels. It is claimed that when working on small parts of steel, brass, aluminium, or plastics, this machine will consistently produce work to a tolerance as close as 0·0001 in.

A Super 60 power quill is shown in the head, developing ½ h.p. at 45,000 r.p.m. The speed is infinitely variable from zero up to this maximum. The ground and honed collet chuck will take shanks up to ¼ in and the arbor will take midget mills up to ¼ in diameter and 1 in cutting edge. The table of the machine measures 12 in by 4 in and has a longitudinal movement of 5 in with a cross traverse of 3 in. The spindle head has a total vertical movement of 3½ in and provision is made for tilting the axis of the head to 45° either side of the vertical. The second mounting allows it to be turned through a full 360° in the other plane.

The movement of the table incorporates an air-hydraulic feed, which is fitted with a speed regulator. The range of feed rates is from zero up to the maximum of 70 in per minute in both directions. Control is by push buttons operating an electric control circuit. The motor runs from a standard 240V mains supply, single phase, 50 cycles. A compressed air supply is required for the table feed. *Newage Machine Tools Limited, 98-100 Croydon Road, London, SE20.*

BATCH FURNACE

Flexible Operation



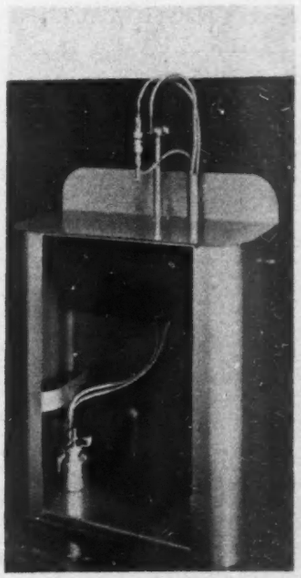
TWO new batch furnaces are suitable for both general and controlled atmosphere work at temperatures in the range from 700 to 1,000° C.

The furnaces utilise the Jetube radiant heating elements which have high recirculation and air/gas firing. Combustion occurs in a refractory lined section of the tube and the burnt gasses leave through a nozzle at high velocity. In so doing they entrain hot gases already circulating in the body of the tube and build up recirculation. Special advantages claimed are that the tube is protected from the high temperature gasses leaving the nozzle and that there are no hot spots. The large mass flow gives high heat transfer and the efficiency can be improved by fitting a recuperator.

The furnace chamber is lined with high efficiency low thermal storage capacity materials. The result is a very flexible unit that attains working temperature rapidly, for a low fuel consumption. A perforated nickel-chromium hearth is fitted as standard equipment. The design is intended to give easy access to all parts. As optional extras the furnaces may be fitted with completely automatic temperature and programme control; electric ignition; and automatic flame curtain to minimise air infiltration when the door is open. The two standard sizes have work chambers measuring 36 in by 24 in by 12 in, and 48 in by 36 in by 18 in. *Incandescent Heat Company Limited, Cornwall Road, Smethwick, Birmingham.*

APPLICATOR

For Brazing Pastes



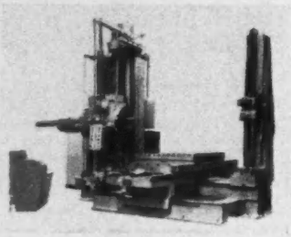
THE Efco applicator is an air operated unit designed to spread brazing pastes over the workpiece, under the control of a foot switch.

The unit has a sheet metal cabinet housing air lines, paste container, and the operating foot switch. The working surface is 3 ft above ground level. The head of the machine, containing an air operated plunger and a paste extruding nozzle, is supported on a vertical post above the cabinet where it can be moved vertically and horizontally to suit the work in progress.

Inside the cabinet, and protected by a sheet metal cover, are an air filter, a pressure regulator and gauge, and an oil mist lubricator. The screw-top paste container conveniently stands on the floor of the cabinet where it is accessible for refilling. The overall dimensions of the unit are 2 ft 8 in by 15 in by 4 ft high to the top of the support post. *Electric Resistance Furnace Company Limited, Netherby, Queens Road, Weybridge, Surrey.*

BORING MACHINE

Electronic Coordinate Setting



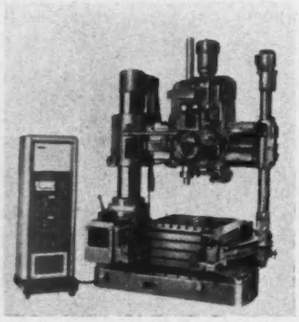
THE universal surfacing, boring, milling, drilling, tapping, and screwcutting machine No. 3WB has been specifically designed to take advantage of electronic coordinate setting.

The system used is the AEI two-dimensional control which comprises servo mechanisms operating the vertical traverse of the spindle slide and the transverse movement of the main table. The co-ordinates of the position are set up on dials on the control desk, giving the position in tens of inches, inches and four decimal places, from any chosen datum. The dials can be set individually by hand or in groups by a punched card. In the latter case sequence operation can be carried out by automatic changing of the cards as each operation is completed.

The machine is arranged to operate on workpieces up to about six tons in weight. The 4 in diameter spindle is combined with a built-in facing chuck capable of machining up to 42 in diameter, and fitted with a patented feed mechanism to the slide. Unit principle has been used in the construction. The main table is 4 ft by 9 ft and is fully supported by carrying it on a saddle supported in turn on the main bed, having a total width of 8 ft 9 in. A multi-jack revolving table measuring 5 ft square is mounted on the main table and can accommodate an offset load. A gearbox in the spindle slide gives a choice of four speeds which coupled with the eight speed main box gives an overall range of 32 speeds. The transverse traverse is 8 ft and the vertical travel 7 ft. Total horse power is 30. *H. W. Kearns and Company Limited, Broadheath, Nr. Manchester.*

JIG BORER

Automatic Setting



DOUBLE columns give the Oerlikon R 2 jig borer rigidity for rapid production and heavy duty work.

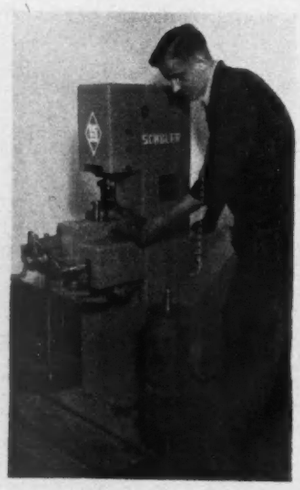
Coordinate setting of the machine from the console can be carried out using the hand set dials, punched cards or tape. Once in position the quill head locks electrically. The outer column of the machine is arranged to move though an arc to allow the loading of large and heavy workpieces, which can be mounted on the front of the table as the long traverse of 42½ in allows them to pass under the tool head.

The spindle is supported throughout the length of the stroke close to the tool which, with the rigid frame, allows high rates of metal removal. The table slide-ways are fully protected. Since, owing to the long travel, work can be mounted on the front face of the table the useful height of the machine is increased. With a 24⅛ in diameter circular table mounted on the angle bracket, work can be machined on all four sides without having to disturb the setup.

The distance between columns is 58⅛ in and the table traverse 42½ in. The drilling capacity in cast iron is up to 2⅞ in diameter. There are 18 spindle speeds ranging from 38 to 1,900 r.p.m. and 15 feeds from 0·0012 to 0·032 in per revolution. The main motor is rated 6 h.p. *Dowding and Doll Limited, 346 Kensington High Street, London, W14.*

NOTCHING MACHINE

1,000 Strokes per Minute



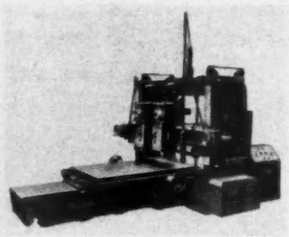
ILLUSTRATED is the smallest in the range of Schuler notching machines, the MNu 360.

The complete range has five models, the largest taking work up to 88 in diameter. The speed is up to 1,000 strokes per minute with a lower limit of 320. As shown the machine is fitted with automatic saddle adjustment for notching the laminations for conical rotors and stators, and engagement is pneumatic to reduce operator fatigue. All moving parts are totally enclosed except the tool station itself. The covers are hinged so that immediate access is possible, for setting or adjusting purposes.

The capacity of the MNu is for sheet up to 1 mm thick (0·04 in approximately) with a depth of throat of 3½ in. The stroke of the ram is 0·512 in and the pressure 2000 kg maximum. The maximum blank diameter than can be accommodated is 14·2 in and the minimum 0·79 in. Operation rates vary from 320 to 16,000 strokes per minute. The design has given a smooth exterior with clean lines. *Pearson Panke Limited, 1–3 Hale Grove Gardens, London, NW7.*

PLANO MILLER

40 in Clearance under Quill



THE plano miller type WT6 illustrated is designed as an inexpensive machine for all general work on components up to 8 ft long by 5 ft wide.

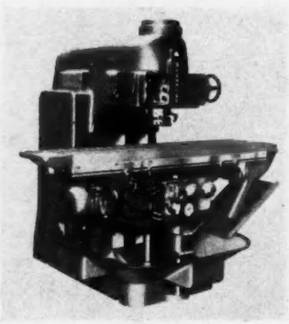
The clearance between the spindle nose and the table is 40 in and the design is intended to enable all classes of material to be machined using a wide range of spindle speeds and infinitely variable feeds. The machine is arranged to carry either one or two heads each comprising a rigidly mounted spindle carried in a 7½ in diameter quill. The quill is provided with 6 in of vertical movement and is counter-balanced. The spindle is on taper roller bearings and driven from a 5 h.p. motor through a gearbox with a choice of 6 speeds from 50 to 500 r.p.m.

A motor and gearbox on the beam raise and lower it through vertical screws and nuts at 12 in per minute. The complete headslide unit traverses the horizontal beam at feed rates from 0 to 24 in per minute obtained from a Ward Leonard set. Fast traverse is 60 in per minute. There is hydraulic locking on the slides.

The table is 9 ft 4 in long by 58 in wide and has a longitudinal travel of 8 ft at speeds infinitely variable from 0 to 24 in per minute in both directions. Fast traverse is 60 in per minute. The table is driven from a 2 in Acme screw and runs on hardened and ground inserts with precision roller chains for easy movement. The table is fitted with narrow guide location and taper gibs. All principal controls are housed in the pendant, and handwheels are duplicated on both sides of the machine. *Wadkin Limited, Green Lane Works, Leicester.*

HEAVY DUTY MILLER

Fast Metal Removal



ILLUSTRATED is the Richmond No. 5 vertical milling machine designed for high rates of metal removal using carbide tools.

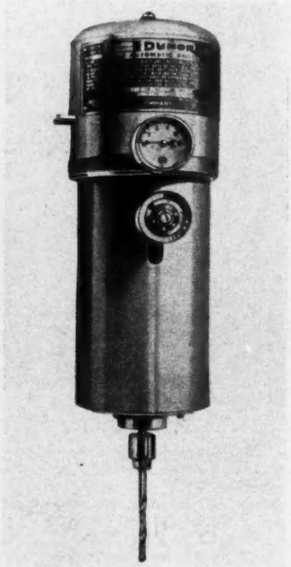
Power is supplied by a 20 h.p. 2 speed main motor which is built into the column. Also in the column are the spindle and main drive gearbox, which is a self contained unit mounted coaxially with the spindle and having only two lines of high tensile steel shafting, mounted on ball and roller bearings. Five magnetic clutches and ten gears operating in conjunction with the two speed motor give a total of 12 spindle speeds in the range from 200 to 2,500 r.p.m., controlled by an independent selector switch. In the base is a suds pump and reservoir.

The table has a longitudinal movement of 33 in provided by a hydraulic system contained in the knee and slide structure. This permits variable feed rates from 1 in to 200 in per minute with a quick traverse of 250 in per minute.

The spindle is of nitralloy steel with a No. 50 taper and runs in roller bearings. The thrust is taken by a pair of angular contact ball bearings mounted in an adjustable quill with a pair of ball bearings in the upper housing. The spindle has a vertical movement of 4 in controlled by a hand wheel with micrometer dial. The knee bracket is of reinforced solid top construction and the saddle provides a long bearing surface for the table. *Midgley and Sutcliffe Limited, Hillidge Works, Hunslet, Leeds 10.*

DRILL HEAD

Electro-Pneumatic Action



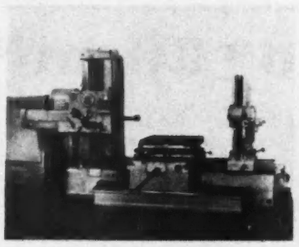
THE Dumore drill head for small holes is automatic in operation.

Power is supplied by an integral electric motor which rotates the drill and also drives a vane compressor. Air from the compressor is fed to the top of the unit and forces the whole motor assembly towards the work. A regulator adjusts the air pressure and therefore the pressure exerted by the drill against the work. When a preset depth has been reached an exhaust port opens and releases the pressure, stopping the advance. A coiled spring returns the drill to the starting point.

The unit measures 14½ in long by 4½ in diameter. The weight is 17½ lb. The stroke is 1½ in and can be controlled by the depth setting to within 0·004 in. Recommended drilling sizes are ⅜ in in steel or ½ in in brass, aluminium, zinc, or cast iron. It is claimed that the adjustable feed pressure and speed result in fewer drill breakages. *Gaston E. Marbaix, Limited, Vicarage Crescent, London, SW11.*

HORIZONTAL BORER

Optical Setting



It is claimed that the optical measuring system used on the Plauert WH63 borer makes it suitable for both production and jig boring work.

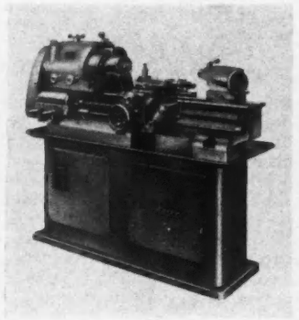
The settings of the table can be made and read to an accuracy of 0·0004 in in both directions, with a cross travel of 40 in and longitudinal travel of the same amount. The vertical travel of the headstock on the column is 28 in. The very wide bed, measuring 59 in, gives excellent support to the rotary table enabling work pieces up to 2 tons to be carried on a working surface measuring 32 in by 35½ in. There are 26 feed rates for the table ranging from 0·008 in to 0·25 in per revolution of the spindle. Fast traverse is 64 in per minute.

The spindle is a sliding fit in the quill and is tapered to take the tool. The quill itself is flanged to take direct mounting of large face milling cutters and other accessories. There are 21 spindle speeds from 18 to 1,800 r.p.m. and the maximum travel is 22 in. The spindle itself has a diameter of 2½ in.

Simplicity of control has been an aim of the design. All controls governing machining movements are therefore grouped for operation from one position. A single lever controls automatic feeds to both spindle head and table slides, and oblique surfaces up to 45° can be milled by engaging both feeds at once. On the same lever is the push button control for the rapid traverse, rapid movement continuing as long as the button is pressed, normal feed being restored on release. Spindle speeds and feeds can be preselected. *Selson Machine Tool Company Limited, 23-25 Sunbeam Road, London, NW.10*

CENTRE LATHE

13 in Swing



The latest addition to the Kerry range of lathes is the 11/13 in machine for sliding, surfacing and screwcutting.

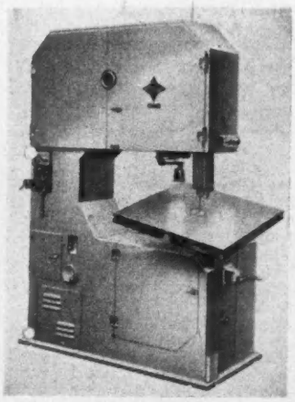
The lathe has an all geared headstock driven from a single speed motor of 2 h.p. and giving 12 spindle speeds over the range from 40 to 2,000 r.p.m. A feed reverse is incorporated. The main spindle has a 1 $\frac{5}{16}$ in diameter bore and is mounted on opposed taper roller bearings at the front and a roller bearing at the rear. The hardened nose is the type LO American standard and is fitted with a 5/3 taper sleeve to accept No. 3 Morse taper centres.

The Norton type feed box provides 55 pitches from 4 to 448 threads per in and includes 19 t.p.i. on the English version. On the American version this is replaced by 11½ t.p.i. The power feeds available are seven in number and range in geometrical progression from 0·0004 in to 0·028 in per revolution of the main spindle for both the sliding and surfacing motions. Engagement of surfacing and sliding is by a single lever gate change which is interlocked with the screwcutting equipment. A built-in screwcutting dial is fitted as standard equipment.

The saddle carries a broad cross slide and a compound slide adjustable through the full circle. The tailstock is of the through bore type with offset handwheel feeding the barrel by a worm. *Kerry's (Engineering) Limited, Warton Road, London, E15.*

BANDSAW

Deep Throat Capacity



Increased horizontal capacity is the main claim for the Deep Throat saw/filer machine.

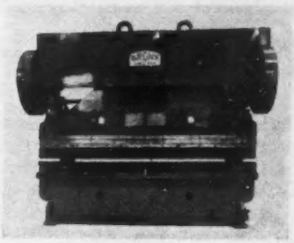
In order to make this possible, a third wheel is introduced to take the blade. Work up to 36 in can be accommodated in the throat. The table measures 30 in by 30 in and can be tilted four ways: 45° to the right, 10° to the left and 10° front and back. The maximum thickness of work is 14 in for both sawing and filing.

The main saw wheels top and bottom are 22 in diameter and the third intermediate wheel which can be by-passed for filing is 16 in diameter. The widths are 1½ in. Blade lengths are from 203 to 208 in when three wheels are used, and from 164 to 175 for two-wheel operation. Speeds are infinitely variable from 50 to 1,600 ft per minute. Blade tension is by compression spring.

Two saw guides are fitted as standard, one below and one above the table. Each has carbide thrust pads. A single speed motor supplies the drive, speed control being obtained by a handwheel and variable pitch pulleys. An automatic feed device with a wide range of operating pressures is also fitted. A guillotine and butt welder are mounted on the front. *Midland Saw and Tool Company Limited, Midsaw Works, Pope Street, Birmingham 1.*

PRESS BRAKE

90 Ton Capacity



A welded steel press brake has a capacity for work between the columns of 10 ft by 10 gauge.

The frame is stress relieved and the bottom beam rests on machined abutments on the two side columns and is welded in position to form with the top beam a rigid box construction. The top beam is of ample depth to resist deflection and can be adjusted by a separate flange mounted motor driving a train of reduction gears running in oil. A dog clutch is provided so that the top beam can be positioned parallel to the bottom beam. Limit switches prevent overrun.

The connecting rods are of cast iron and are fitted with phosphor bronze bush bearings for the eccentric shaft throws. Spherical ended ball screws raise and lower the top beam. The eccentric shaft is hammer forged in one piece and works in phosphor bronze bearings.

The drive is provided by a high torque motor through V belts direct to a flywheel running on ball and roller bearings on the first motion shaft. A multiplate friction clutch allows inching.

The width of the press over the beams is 12ft and between columns 10 ft 4 in. It will run at up to 30 strokes per minute, with a stroke of 3 in. The die space with the stroke down and the adjustment up is 12 in, the top beam adjustment being 4 in. The gap in the columns is 10 in. The main motor is rated at 8 h.p. and the beam adjuster motor at 1½ h.p. A particular claim is that the machine occupies the minimum of floor space. *Bronx Engineering Company Limited, Lye, nr. Stourbridge*

DEBURRING MACHINE

For Gearwheels

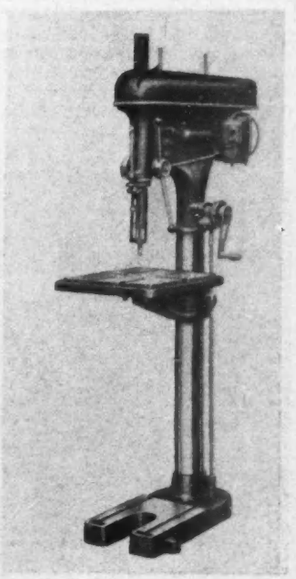
The Parkson Gearbur is a machine designed to remove the sharp edges and burrs from the side of gear teeth.

The machine uses a helical profiled grinding wheel that engages with the teeth of the gear wheel which is mounted on an arbor and is free to turn. The grinding wheel is 8 in diameter and is mounted on the upper end of a vertical shaft running on ball bearings, and driven by a 1 h.p. vertical spindle motor. A spring operated brake is mounted on a shaft extension below the motor. Grinding dust is exhausted to a water settling tank with a removable top cover, and clean air passes to the rear of the cabinet. The exhaust equipment is contained in the lower front panel and the electrical equipment in the left cupboard.

The machine will take gears up to 11 in diameter by 11 in long, with teeth from 25 to 5 d.p. The floor space required is 20 in by 46 in. The right hand cupboard of the base has a hinged door and contains shelves for the storage of tools and grinding wheels of which there must be one for each pitch and pressure angle. Both spur and helical gears can be cleaned on the machine. Short floor-to-floor time and very clean finish to both root and sides of the teeth are two main claims, coupled with good grinding wheel life. *J. Parkinson and Son (Shipley) Limited, P.O. Box 28, Shipley, Yorkshire.*

SENSITIVE DRILL

$\frac{7}{8}$ in Capacity



The Denbigh type K1A series 2 sensitive drill has a capacity up to $\frac{7}{8}$ in.

The drive is from a motor of ¾ h.p. rating with five spindle speeds from 400 to 2,800 r.p.m. The spindle is operated by a rack and pinion with an adjustable clock spring for return. The feed is 5¼ in. Clearance of the column allows drilling to the centre of a 21 in circle. A graduated depth stop is fitted at the front of the machine.

The table has a 16 in square working surface and a vertical movement of 31½ in. Operation is by crank and bevel wheels to the screw. It can be swung radially round the column allowing work to be placed on the base and increasing the machine capacity from 34 in to 45 in.

A guard completely covers the cone pulleys but can be lifted by depressing a single lever to allow belt changing. A patented tensioning device slacks the belt for a quick change. *Fenter Machine Tools Limited, 184 Aston Road, Birmingham 6.*

Cushioncraft: Ground-Effect is Direct

Using a peripheral compressor and standard automotive and helicopter components, the Cushioncraft is a low-cost simple ground-effect machine designed for service in equatorial countries.

BRITAIN'S two current ground-effect machines, the Hovercraft and the Cushioncraft, are as different in their details as an aeroplane and a racing car. Yet the Cushioncraft was not designed just to be different, or to avoid patent infringement. The aim of the designers, John Britten and Desmond Norman, was a simple machine that would handle like a truck and could be built using the resources of their own company: a small stall among the supermarkets of the aircraft industry.

The incentive came from Elders and Fyffes, the banana growers and importers, who recognised that ground-effect machines would be ideal to transport materials in underdeveloped areas where paved roads are non-existent and the rivers either flood or dry up. Risking mostly their own money, Britten and Norman first decided to build the smallest and cheapest machine possible. But with ground-effect machines, the smaller the craft, the more difficult it is to design. The support area of the craft diminishes with the square of diameter, but the air flow and power requirements are a linear function. Soon a point is reached where the craft will not lift the weight of the required prime mover. Hence the minimum size can only be reduced through improved lifting efficiency and reduced weight.

Britten and Norman took a good look at the Hovercraft, which they greatly admire, and detected a number of points where efficiency might be improved and costs reduced. Handling large volumes of air at a fair velocity, ground-effect machines are quite sensitive to duct losses. The ducts are needed to take air from the blower to the peripheral seal that maintains the air cushion under the craft. Britten-Norman's solution is illustrated below: a saucer-shaped craft with the blower placed where it is needed, on the periphery. Length of ducting: zero for all practical purposes.

The second point that occurred was that ground-effect machines can derive some lift by conventional means. The Hovercraft benefits from helicopter and jet effects, and so does the Cushioncraft. But in the latter the lips of the peripheral blower intake act as annular airfoils because the air passing over the lips is below atmospheric pressure as a result of blower suction. The same effect in the Hovercraft is negligible. About one third of the total lift is derived from the secondary effects.

Another important difference between the two machines is that the Cushioncraft handles air at a lower velocity—60 ft per sec instead of about 120. Although still quite a breeze, there is less tendency to blow stones and spray into the air.

The general shape of the prototype was thus determined by the blower: a circular platform for the prime mover, driver and cargo which also serves as the axle for a wheel of blower blades. Stator blades below the blower support the outer stator ring and remove the rotational component of the exit air. The problem was then to find a suitable prime mover.

Though turbine engines have a fine specific power output, they cost about ten times more than a standard car engine in small sizes. For jungle service, some robust truck engine is envisaged, but for the small prototype a 2 litre 170 b.h.p. Coventry Climax racing engine was chosen. The final drive consists of an MG gearbox and a sports-car wheel (complete with knock-on hub and Michelin X tyre) which runs on a rubber covered track provided on the blower rotors: the simplest form of friction drive. The rotor is supported on sets of rubber rollers at six points around the periphery.

TRIALS IN THE CAMEROONS

The propulsion equipment consists of two second-hand tail rotors from a helicopter, driven directly from the friction-wheel shaft. The rotors have independently controllable pitch, so that forward or backward speed, braking and steering are all controlled, aircraft-fashion, from a single wheel. A greal deal of inherent stability has been built into the Cushioncraft. With an inexperienced operator (hovering time with the Cushioncraft is still counted in minutes) and no control action there is only a slight tendency to wander.

The designers do not claim that all the problems have been solved. Control still gives some trouble and the rubber support rollers of the rotor need to be tested with many hours of hovering. The next steps will be to learn to operate the machine over land or water, and to evaluate the performance. If satisfactory, the machine will be shipped to the Cameroons and tested under realistic operating conditions later this year.

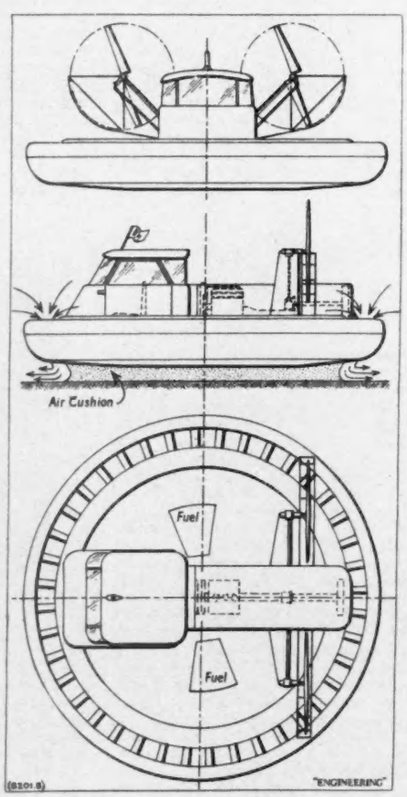
Future models of the Cushioncraft, described as a large tubeless tyre with the casing removed, will be much larger. A rule of thumb states that a ground-effect machine can lift the equivalent of its dry weight in disposable load, and the first model weighs only about a ton. Later the circular shape may be abandoned and blower blades mounted on a conveyor belt used instead. Alternatively, a shape composed of two or three circles can be used. Both lateral control and propulsion can be accomplished by adding a separate engine, or by bleeding air from the support cushion.

Neither car, boat, nor aeroplane, the ground-effect machine's next-of-kin is the amphibian personnel carrier. Britten-Norman, whose crop-dusting companies have many years of operating experience in equatorial countries, believe that there is already a market for a few hundred Cushioncraft each year for tropical fruit carriers, surveyors, passenger-transport and the like. They point out that the cost of clearing a level path is only a fraction of the cost of building a road, and once built the cost of upkeep is negligible. Although there are many fields of application, ground-effect machines are practically tailor-made for the needs of banana growers. As the fruit bruises easily, and damage is not noticed until the market is reached, a vehicle ensuring a smooth ride reduces costly spoilage.

Once the Cushioncraft is tested and accepted, it will tend to generate new business amounting to several thousand units a year by enabling the economic exploitations of areas which were hitherto beyond the reach of the investor. Such a business volume is comparable to the executive and private aeroplane field and should be sufficient to maintain a fair size company in good financial health.

John Britten and Desmond Norman's achievements are most impressive. They got interested in ground-effect machines for the first time when they saw the Hovercraft at last year's Farnborough Show. The decision to build a prototype with the support of Elders and Fyffe was taken in September, and by June 1960 a very workman-like Cuchioncraft, looking like a piece of bright red farm machinery, was ready for testing. The cost of the first machine is somewhat over £10,000, of which Elders and Fyffe contributed " considerably less than half."

(Left) On its first trials: the three passenger Britten-Norman Cushioncraft.



(Right) Use of a peripheral rotor eliminates the need for air ducting, and made it possible to build a very small prototype.

Two Way Stretch

IT IS not the generating boards' business to devise a nuclear power programme that would suit the needs of the industry; the programme is designed to keep in good health an industry of a size that will suit the needs of the generating boards. Thus Sir Christopher Hinton summerised his views on the third White Paper on nuclear energy, published last week. Three important questions emerge: How big an industry will serve the needs of the generating boards; does that coincide with the needs of the nation; and will an industry of that size be kept in good health by the proposed programme?

Programme Fluctuations

Since its inception, the United Kingdom nuclear power programme has undergone two important changes. The White Paper of 1955 contained a cautious but optimistic plan to develop commercial nuclear power, based on a demonstrated principle, but on untried techniques. Two years later Calder Hall was in operation, and in the turmoil of the retreat from Suez the second plan was formulated, not as a framework of development but to fill a definite need. That need does not exist today, and the Ministry of Power has decided to return to the principles of the first plan: that is, to build power stations in order to gain experience. The two-way stretch of the power programme between 1955 and 1960 is illustrated in Fig. 1. It is hoped that by 1970 the design improvements achieved through the successive trials made possible under the plan will result in competitive power production under United Kingdom conditions.

Needs of the Generating Board

The upper limit of nuclear capacity in any realistic power programme is the available base load. According to Sir Christopher, it is not possible to imagine at present a nuclear power station that could compete with conventional stations in peak load service. In the power system of the British Isles the absolute minimum load occurs on the Sunday preceding the August bank holiday, and is approximately 12 per cent of the winter peak. With a load factor of only 0·60 to 0·70 a somewhat higher value can be considered as the base load, and 15 per cent of the peak is often used. Thus by 1965, when the installed capacity will be around 35,000 MW, the required base load will be only 5,000 MW or less. The revised power programme of 1957, calling for the installation of 5 to 6,000 nuclear megawatts, would have supplied the entire base load of the system. It is open to question whether that plan was ever realistic, even if the flow of oil from the Middle East had stopped completely. Even in 1975, by which time the total installed capacity will be 60,000 MW (estimate of 1955), or 40,000 MW (estimate of 1960), the available base load will be below 10,000 MW.

Expected Business Volume

Putting two and two together —the realisation that nuclear power cannot compete in peak load service, and that the available base load will be only about 6,000 MW—one cannot escape the conclusion that as far as the generating board are concerned, a very small nuclear industry, installing not more than 1 ,000 MW annually, will be sufficient for a long time to come. Assuming that in a few years time the installation cost of nuclear stations will drop below £100 per kilowatt, the annual turnover of the entire nuclear power industry will be of the order of £100 million. For comparison, the gross sales of the Rolls-Royce group of companies, automotive and aircraft, was approximately £90 million in 1959. Such a business volume is sufficient to keep a single large company in good health if it is assumed that nuclear contracting is its sole field of activity.

Medicine Once Every Three Years

Referring to Fig. 1 it can be seen that the White Paper intends to maintain a yearly increase of installed nuclear capacity between 800 and 1,000 MW. With the tendency of increased unit rating, particularly when advanced gas-cooled reactors are beginning to appear (Atomic Review, 24 June, 1960), it is clear that one contract will be placed every year until the economic situation changes in favour of nuclear power, possibly after 1970. Since the construction time of a reactor station is approximately four years, it would appear that four nuclear consortia could be kept continuously occupied under the present programme. (The White Paper is less optimistic regarding construction time, and expects that five or six stations will be in various stages from design to commissioning at any time, though the original construction schedule allowed only 3½ years for Berkeley and Bradwell.) With four consortia, each can hope to land a contract worth £100 million once every four years and maintain continuity, but this does not mean that the contract will maintain employment for the entire engineering staff. The major design effort takes place during the two years in which the tender documents and the detail drawings are prepared, with gradually diminishing activity as the contract reaches the half-way mark. The specialised skills of nuclear design groups are used primarily in tender preparation, and the question must be asked what will such a valuable team be doing for the rest of the time? It was easy to predict that in spite of the assurance of the Minister of Power that the nuclear industry would be maintained in good health by the programme, the industry would contract. The merger of Atomic Power Constructions and the GEC—Simon-Carves Group (see Notes and News) has already reduced the number of consortia that will tender for future stations to three.

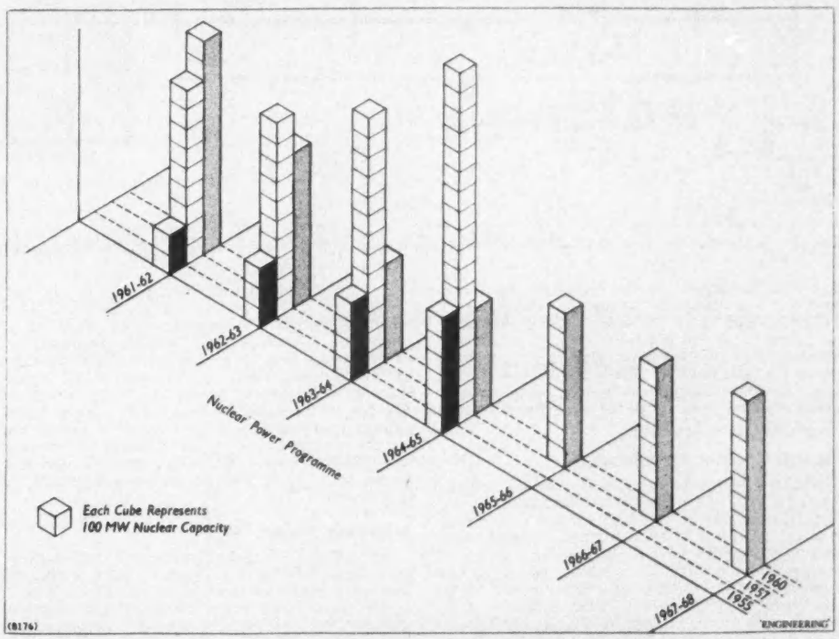


Fig. 1 Changes in the United Kingdom atomic energy programme: the original plans of 1955; the accelerated programme of 1957; and the famous "decelerated acceleration" of 1960, which still exceeds the 1955 estimates.

To Avoid Further Contraction

The aim of the nuclear programme is to effect step-wise improvements in the engineering of power reactors, and from the generating boards' point of view, the most fruitful occupation for the design teams would be to work on advanced reactor concepts while not engaged on actual contracts. But it is questionable whether the consortia will find sufficient incentive in the prospect of one contract every three years to keep the design team working all the time. The logical solution would be to search for export contracts, but if such are not forthcoming, the government will either have to provide added incentives, or accept further contraction. There is little point in building a new station according to a three year old design, particularly when the aim of the exercise is not to produce power but to improve the design.

More Research Contracts

In place of export contracts, the incentive to keep the industrial design teams working can be provided by research contracts. The Central Electricity Generating Board, with its own new research laboratories at Berkeley, is not in a position to sublet research problems to private industry. In fact the CEGB and the consortia may become direct competitors in the field of applied research. The onus of providing the necessary incentive for continued work will thus fall on the UKAEA, and in certain fields the Authority is already taking steps in that direction. An example is the steam cooled reactor concept, in the development of which private industry is expected to participate. If subletting research contracts to private industry becomes the accepted custom, the nuclear industry of the United Kingdom will begin to resemble that of the United States, where of 120,000 persons engaged directly in the national programme, less than 6 per cent are employed by the Government. (Remarks by John A. McCone, Chairman, USAEC, 10 June, 1960.)

Immediate Plans

Although the 1960 White Paper does not affect the power stations already under construction or awaiting award, a few changes have nevertheless been incorporated. Berkeley, Bradwell and Hunterston were awarded at the same time, the end of 1956, but owing to unfortunate delays in construction the third station has now been incorporated in the programme for 1963-64. The tenders for Dungeness have already been evaluated and the contract will soon be awarded, possibly next week. Sizewell, it is hoped, will be awarded in December this year. The table above shows the committed portion of the programme.

Station	*Capacity MW*	*Contract awarded*	*Full load*
Berkeley	275	Dec., 56 ..	1961-62
Bradwell	300	Dec., 56 ..	
Hinkley Point ..	500	Sept., 57 ..	1963-64
Hunterston	300	Dec., 56 ..	
Trawsfynydd	500	Aug., 59 ..	
Dungeness	500	July, 60 ..	1964-65
Sizewell	550	Dec., 60 ..	1965-66
Oldbury	?	61 ..	1966-67

Notes and News

APC-GEC Collaboration Again

Following the announcement of the 1960 White Paper containing the reductions in the atomic energy programme, it took only two days to reconcile the outstanding differences between Atomic Power Constructions and the GEC—Simon-Carves Group. Having attempted collaboration once before, the two groups have now decided to effect complete merger, reducing the number of active consortia to three.

Losses from Programme Cutbacks

Although the reductions—or stretching out—of hte nuclear power programme will save £90 million

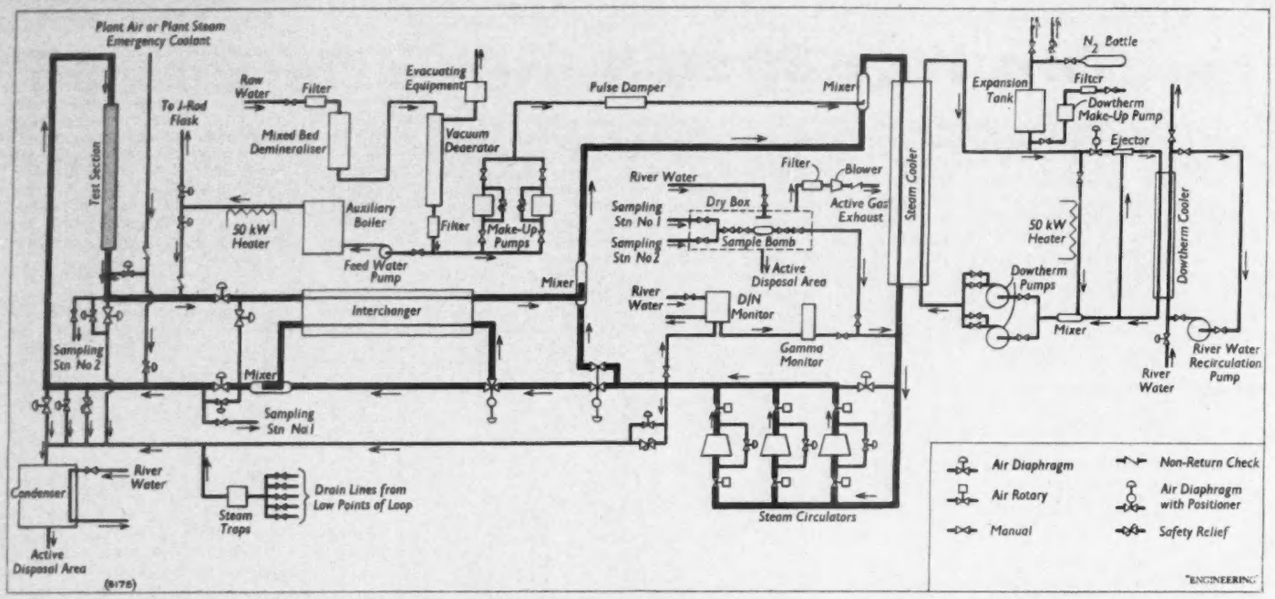


Fig. 2 Schematic arrangement of the steam-cooled loop which Atomic Energy of Canada plans to install in the E12 position of its NRU reactor.

n capital investment to the electricity generating boards, a loss amounting to several million pounds will be chalked up by the Atomic Energy Authority as a result. In preparation for the accelerated programme of 1957 the UKAEA took early steps to secure uranium fuel. It is too late for cancellation now. Inventory charges on the fuel stocks, some of which will have to be stored for many years, account for the loss.

Canadian Work on Steam Cooling

With increasing interest in steam-cooled reactors, Atomic Energy of Canada Limited decided to investigate the possibility of installing a steam cooled loop in channel E12 of the NRU reactor. A design contract was awarded to Orenda Engines Limited of Malton, Ont., a sibsidiary company of A. V. Roe Canada Limtied, which in turn is a member of the Hawker Siddeley Group. A schematic layout of the experimental loop is shown in Fig. 2. Provision is made in the loop circuit for normal activity monitoring, for steam sampling at various points, for emergency cooling in the event of a pipe failure, and for decontamination should this be necessary. The control system is tied into the main reactor controls and interlocks. In addition to having its own make-up water purification system, an auxiliary boiler and 50 kW heater is provided to produce the initial steam for start-up. The loop is designed to cool a 10 ft fuel element with a rating up to 2 MW. The range of variables are the following:

Fuel	Uranium oxide
No. of elements per rod	19
Heat ratings at—	
900° F sheath temp. ..	49 watts per cm
1,300° F. sheath temp.	41·4 watts per cm
Sheath outside diameter..	0·500 in and 0·550 in
Outside diameter of bundle	3·00 in and 3·500 in
Nominal test section inlet temp.	460° F to 600° F
Nominal test section inlet press.	600 to 1,500 lb. per sq. in
Maximum test section outlet temp.	1,000° F

Steam Circulators

Coolant is circulated by two single-stage centrifugal compressors of Orenda design, operating in parallel and driven at constant speed by two a.c. motors through speed increasers. An emergency d.c. motor is connected to each a.c. motor through an overriding clutch which engages to power the circulator at a reduced speed in the event of power failure. The circular impeller shaft is supported by water-lubricated sleeve bearings in conjunction with a Kingsbury-type thrust bearing. The seal and bearing assembly housing, complete with shaft and impeller, may be removed from the circulator as a unit. The test section has been designed to make the maximum use of the hole available in the reactor. The sump has been modified to allow entrance of the steam, to allow thermocouple take-offs which do not require a manual disconnect, but allow the rod and integral shieldings to be removed automatically by the rod handling flask. To prevent the reactor deck from becoming too hot a water jacket has been added to the stump. Orenda Engines are also working on an improved fuel element for the NRU reactor. Several configurations of an array of 19 round elements with various means are being evaluated. The aim of the design is to arrive at a more stable element containing the same amount of fuel as the current models, but using less cladding and causing less pressure drop. The programme has proceded to the point where samples are being prepared for irradiation.

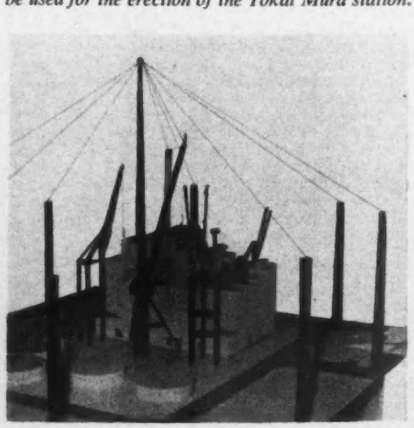
Accelerator Makers Unite

High Voltage Engineering Corporation of Burlington, Massachusetts, have acquired all the stock of Applied Radiation Corporation (ARCO) of Walnut Creek, California. High Voltage Engineering are the most important manufacturers of particle accelerators in the world, with over two hundred machines in operation. ARCO have specialised in high energy radiation machines—microwave linear accelerators and Cockcroft-Walton devices—so that the two companies will complement each other in allied branches of engineering. In addition, ARCO have special connections with Project Sherwood of the USAEC for controlled thermonuclear reactions.

Improvements in Airfilters for Radioactive Dust

Important improvements have been made in the performance of filters designed for the removal of radio-active dust particles from a gaseous carrier. It is possible to achieve a filtration efficiency on air, using methylene blue as a standard, of 99·999 per cent in a unit measuring only 2 ft by 2 ft by 5 ft 6 in and processing 1,000 cu. ft of air a minute. Of particular importance to bare-fuel high-temperature reactors is the fact that the filtering medium is composed entirely of non-combustible materials suitable for operation up to 500° C. Using primary separators to remove all the coarse particles, the life of the fine filter elements should be " several years " when applied to air filtration in industrial plants. (P. A. F. White and S. E. Smith: " Removal of Radioactive Particulates from Air," *Research Applied in Industry*, vol. 13, no. 6, June, 1960.)

Fig. 3 Model of the lifting equipment that will be used for the erection of the Tokai Mura station.



Recovery of Thorium Traces from Uranium Ores

In certain uranium ores, particularly in Canada's Blind River area, traces of thorium in commercially significant concentration are found. The thorium traces are not recovered during uranium extraction and are at present passed to waste. Solvent extrae tion methods have been devised for the treatment of the barren solutions from uranium plants with 98 to 99 per cent thorium recovery. The solvents are EHP (di-2-ethylhexyl hydrogen phosphate) and the long-chain primary amine Primene JM-T in kerosine. The reagent costs per pound of recovered thoria is 27·2 cents for the EHP process and 50·0 cents for the amine process. The choice of reagent will depend primarily on the composition of the uranium ores, EHP being more suitable for ores containing little ferric iron or phosphate. (A. Audsley, W. Ryan and R. A. Wells, " Recovery of Thorium from Uranium-plant Barren Solutions by Solvent Extraction, *Bulletin of the Institution of Mining and Metallurgy*, June 1960, No. 643.)

Reactor Notes

After AGR—Some More Magnox: Sir Christopher Hinton stated at a Press conference that the first commercial advanced gas-cooled reactor would be followed by more Magnox canned stations.

Fourth Reactor in Sweden: R2-0, Swedens low power research reactor, became critical with a loading of 3,356 gr of uranium 235 on 20 June.

Monitors for First Generation: The CEGB has placed an order for 86 portable radiation monitors with Ekco Electronics in preparation for the criticality of Berkeley, Bradwell and Hinkley Point.

No Goliath for Tokai Mura: A 460 ft high derrick will be used in conjunction with two auxiliary monotower cranes at the construction of the Toaki Mura power station instead of a goliath crane. A model of the lifting equipment is shown in Fig. 3.

Three More Nuclear Submarines: Westinghouse Company received the contract to supply reactors for three more nuclear submarines to be built for the US Navy. The contract is worth over $12 million.

German-Euratom Ship Project: Suggestions for a joint German-Euratom programme for the development of nuclear ship propulsion are being prepared. The arangement may amount to financial backing for Germany's marine reactor projects.

'Engineering' Appointments Section

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF SUPPLY

AIRCRAFT AND MISSILE COMPONENT DEVELOPMENT COMPUTER AND SIMULATOR DEVELOPMENT

The Aeronautical Research Laboratories, located at Fishermen's Bend, Victoria, have vacancies for staff to carry out work on Guided Missile development. Applications are invited for the following positions:—

PRINCIPAL EXPERIMENTAL OFFICER (TWO (2) POSITIONS)

SALARY:
£2525 to £2720 (Australian currency).

DUTIES (1):
Responsible for the technical direction of a team engaged on the design and development of aircraft and missile mechanical and electromechanical components.

QUALIFICATIONS:
Degree or equivalent qualifications in Science or engineering, with considerable experience in the design and development of precision components for control of aircraft or guided missiles. Some experience in leadership of development groups desirable.

DUTIES (2):
Responsible for the planning, conduct and analysis of the results of trials of guided missiles. Direct a small team engaged in this work.

QUALIFICATIONS:
Degree or equivalent qualifications in mechanical or aeronautical engineering with considerable trials experience, preferably in guided missiles. Some experience in the analysis of trials results an advantage.

EXPERIMENTAL OFFICER, GRADE 3.

SALARY:
£1730 to £1950 (Australian currency).

DUTIES (5):
Responsible to a Senior Scientific Officer for design development concerned with the development of analogue computation and simulation facilities. Supervision of staff engaged on this work.

QUALIFICATIONS:
Degree or equivalent qualifications in electrical engineering or physics. Several years' experience in the above, or a related field of work.

TRAVEL:
Under specified conditions, first class air/sea transport for the appointees and dependants (wife and dependent children) will be provided by the Commonwealth.

CONTRACT EMPLOYMENT:
If desired by the successful candidates consideration may be given to entering into an agreement for a three (3) or five (5) year contract of employment in Australia. In this case the Commonwealth will bear the cost of return fares; together with the cost of removing the successful applicants' furniture and effects up to a maximum cost of £500 (Aust.), £250 each way.

APPLICATIONS:
Forms obtainable from the Senior Representative (AV. 68/3) Department of Supply, Australia House, Strand, London, W.C.2, with whom completed applications should be lodged by 29th July, 1960. C 417

PUBLIC APPOINTMENTS

BRITISH RAILWAYS (SCOTTISH REGION) ASSISTANT WORK STUDY INSTRUCTOR

British Railways require for their Scottish Region Work Study School at Glasgow an Assistant Work Study Instructor with sound knowledge of Work Study Techniques and lecturing experience. Practical experience in applying incentive bonus schemes desirable, and applicants should have ability to undertake and supervise Work Study investigations.

Salary £1260 rising to £1490 per annum. Travel facilities. Contributory Superannuation Scheme. Applicants will be in competition with candidates from within the Commission's service.

Applications, stating age, education, experience and qualifications, should be addressed to the GENERAL MANAGER, BRITISH RAILWAYS, 302 BUCHANAN STREET, GLASGOW, C.2.

C 430

LECTURESHIP IN ENGINEERING UNIVERSITY COLLEGE OF SWANSEA

A vacancy exists for an ASSISTANT LECTURER or LECTURER in the Department of Engineering at Swansea. Applicants should preferably have interests in the general field of Strength of Materials, but those with interests in any branch of either Civil or Mechanical Engineering will be considered.

ASSISTANT LECTURER:
Applicants should hold a good Honours degree and have at least one year's industrial or post-graduate experience. Research work is strongly encouraged and the assistant may register for a Ph.D. degree.

LECTURER:
Applicants should hold a good Honours degree and have not less than three year's post-graduate research or industrial design experience. It is hoped to appoint a man who will be active in some field of research of his own choice, although if he so wishes, he may join an existing project.

The salary scales are:
Assistant Lecturer: £800 to £950 per annum.
Lecturer £1050 to £1850 per annum.
and the initial salary can be at any point within these ranges. F.S.S.U. benefits and family allowances.

Further particulars can be obtained from the REGISTRAR, UNIVERSITY COLLEGE, SINGLETON PARK, SWANSEA, with whom applications (six copies) should be lodged before 15th July, 1960. June, 1960.

C 444

MSL *have been retained to advise on the appointment of a*

TECHNICAL MANAGER

to join the top team of an engineering firm developing, designing and selling mechanical and chemical plant and equipment for large projects on an international scale.

He will be responsible to the Managing Director for the control and guidance of a technical staff of 50 and for the technical direction of all contracts from enquiry to commissioning overseas.

Candidates must hold membership of a chartered engineering institution and preferably a university degree. A thorough knowledge of process working and steam utilisation is essential. Responsibility for technical negotiations on major projects, evidence of advanced design work, and published technical articles are very desirable.

Preferred age 45 to 50 years. Initial salary up to £3000, with pension, with prospects of a board appointment. Some overseas travel will be necessary.

Please send brief details in confidence, quoting reference F. 2491, to J. G. Smith. In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

MANAGEMENT SELECTION LIMITED, 17, Stratton Street, London, W.1

C 416

CITY OF NOTTINGHAM APPOINTMENT OF CITY ENGINEER AND SURVEYOR SECOND ADVERTISEMENT

Applications are invited from persons who have the necessary experience and qualifications for the appointment of CITY ENGINEER AND SURVEYOR at a salary within the scale of £3340 rising by one increment of £115 and two further increments of £110 to £3675 per annum, the commencing point to be fixed according to the circumstances.

The gentleman appointed will be required to devote the whole of his time to the duties of the office and will not be permitted to hold any other appointment or engage in any other work.

The appointment carries superannuation and the selected applicant will be required to pass a medical examination and to contribute to the superannuation fund.

Applications, stating age, previous experience and present position, accompanied by two testimonials and the names of two persons to whom reference can be made, must be delivered to me not later than the last post on the 15th July in an envelope endorsed "City Engineer."

The gentlemen who sent in applications in reply to the first advertisement need not send in applications again, but must notify me if they desire to be considered.

T. J. OWEN,
TOWN CLERK.

THE GUILDHALL,
NOTTINGHAM.

C 423

AIR MINISTRY

AIR MINISTRY Works Designs Branch requires in LONDON CIVIL ENGINEERING DESIGNER DRAUGHTSMEN with adequate training and drawing office experience in one or more of the following:—

(a) Roads, pavements, earthworks and storm-water drainage.
(b) Foul drainage and sewage disposal.
(c) Water supply and distribution.

Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially. Salary ranges from £680 (at age 25) to £900 per annum. Commencing salary dependent on age, qualifications and experience. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.d. LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or apply to any Employment Exchange quoting King's Cross 3746 giving age, details of training, qualifications, full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 889

CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH and DEVELOPMENT DEPARTMENT

ASSISTANT TECHNICAL ADMINISTRATIVE OFFICER

Applications are invited from ENGINEERS OR SCIENTISTS for the above post at Headquarters, London, S.E.1.

The successful candidate will be responsible to the Technical Administrative Officer and will be required to study and advise on the administration methods necessary for the correct functioning of a large research organisation including the proper co-ordination of research in related fields and the application of research to Industry and will be required to take responsibility for the inception and supervision of procedures. Having such objects in view **candidates should have a Degree in Science or Engineering, or evidence of a sound Scientific or Engineering training, together with a high level of education in subjects appertaining to the problems of co-ordinating human endeavour.** They should also be capable of preparing or editing reports incorporating technical matter derived from specialist research reports and be able to deal with general and research policy.

The post would be suitable for a research scientist wishing to obtain administrative experience before returning to a senior scientific post or a person who has held a responsible technical post and has an interest in the application of research in modern Industry.

SALARY WITHIN THE RANGE £1695—£2045 p.a.

Applications stating age, qualifications, experience, present position and salary, to the PERSONNEL OFFICER, 24/30, HOLBORN, LONDON, E.C.1, BY 18TH. JULY. Envelopes should be marked "Confidential Ref. ENG/229." C 412

BRITISH INDUSTRIAL PLASTICS LTD.

DRAUGHTSMEN

B.I.P. Chemicals Ltd., Oldbury, Birmingham, have vacancies for Draughtsmen with experience in plant layout and design. The company offers good conditions of employment and has a generous Pension and Life Assurance Scheme.

Applications should be made in writing giving full details of qualifications and experience to :—

Personnel Manager,
B.I.P. Chemicals Ltd.,
Oldbury,
Birmingham

C 415

STAFFORDSHIRE COUNTY COUNCIL
EDUCATION COMMITTEE
STAFFORD COLLEGE OF TECHNOLOGY

PRINCIPAL: R. S. PARADISE, B.Sc.(Eng.) Hons. M.I.MECH.E., A.M.I.MAR.E.

Applications are invited for the following new posts:—

1. SENIOR LECTURER IN ELECTRONICS.
2. LECTURER IN ELECTRICAL ENGINEERING.
3. SENIOR LECTURER IN MECHANICAL ENGINEERING.
4. LECTURER IN MECHANICAL ENGINEERING.
5. TWO LECTURERS IN MATHEMATICS.

Duties to commence 1st January, 1961, or earlier if possible.

Salaries in accordance with the Burnham Technical Scales, viz.,

Lecturer ... £1370 by £35 to £1550.
Senior Lecturer £1550 by £50 to £1750.

Removal Expenses and lodging allowances for a period not exceeding six months may, in certain circumstances, be paid to newly appointed married men teachers.

Forms of application, returnable by 18th July, 1960, and further particulars relating to the appointments, may be obtained from the DIRECTOR OF EDUCATION (STAFFING), EDUCATION OFFICES, STAFFORD, on receipt of a stamped addressed foolscap envelope. Candidates should state for which post the form is required.

J. H. P. OXSPRING,
DIRECTOR OF EDUCATION. C 441

UNIVERSITY OF CAMBRIDGE
FACULTY OF ENGINEERING
ASSISTANT DIRECTOR OF RESEARCH IN INDUSTRIAL MANAGEMENT

The Faculty of Engineering intend to appoint an ASSISTANT DIRECTOR OF RESEARCH who will pursue a programme of research into the decision processes in technological departments in industry. Work in this field is already under way in the Department. The appointment will be for a period not exceeding 5 years in the first instance. The pensionable stipends of University teaching officers are under review. The present pensionable stipend of an Assistant Director of Research is £1200 a year rising by annual increments of £50 to £1500 and then by annual increments of £75 to £1650. A non-pensionable allowance of £50 a year is paid for each dependent child. A number of years seniority may be given, if justified by experience, for the purposes of determining stipend. Further details and forms of application may be obtained from the SECRETARY OF THE APPOINTMENTS COMMITTEE OF THE FACULTY OF ENGINEERING, ENGINEERING LABORATORY, CAMBRIDGE, to whom applications should be returned not later than 31 AUGUST, 1960. C 452

CITY OF SHEFFIELD
EDUCATION COMMITTEE
COLLEGE OF TECHNOLOGY
DEPARTMENT OF ENGINEERING

Applicants for the following posts should hold graduate or equivalent qualifications and be adequately experienced in both industry and in teaching.

(*a*) SENIOR LECTURER IN PRODUCTION ENGINEERING (NEW APPOINTMENT)

The person appointed will be expected to teach Machine Tool Theory, Metrology and other Production Engineering subjects of the new scheme of the Institution of Production Engineers to Higher National Certificate and Higher National Diploma students. He will be responsible for the new, very well-equipped Machine Tool and Metrology laboratories. He will be expected to assist in the promotion of research and laboratory work in production engineering subjects, in the development of the Higher National Diploma course and in organising special advanced courses in production subjects. An interest in the application of automatic control to manufacturing equipment will be welcomed.

The following vacancies arise from the appointment of the present holders to higher posts. Corporate membership of the Institution of Mechanical Engineers is essential for both posts.

(*b*) SENIOR LECTURER IN MECHANICAL ENGINEERING

The holder of this post will be required to teach Strength and Properties of Materials and Applied Mechanics A1 and S3 in Higher National Diploma, Higher National and Ordinary National Certificate courses. He will be responsible for the Strength of Materials laboratory and will be expected to assist in the promotion of research, laboratory project work and special advanced courses in relevant subjects. Interest in and knowledge of experimental work in the mechanical deformation of metals will be welcomed.

(*c*) SENIOR LECTURER IN MECHANICAL ENGINEERING

The holder of this post will be required to teach Theory of Machines and Applied Mechanics A1 and S3 in the Higher National Diploma, Higher National and Ordinary National Certificate courses. He will be responsible for the Theory of Machines and Applied Mechanics laboratories and will be expected to assist in the promotion of research, laboratory project work and special advanced courses in relevant subjects. A knowledge of and interest in automatic control devices will be welcomed.

It is desirable that the successful candidates should take up duties on 1st September, 1960.

Salary: £1550 by £50 to £1750 per annum.

Application forms, obtainable from the undersigned (s.a.e.) at P.O. BOX 67, SHEFFIELD, 1, should be returned WITHIN 14 DAYS of the appearance of this advertisement.

T. H. TUNN,
Director of Education. C 371

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

Applications are invited for the position of HEAD OF PRODUCTION ENGINEERING, to take charge of both the Department of Industrial Engineering and the Production Engineering Workshops. Applicants should be well qualified academically, should have had industrial experience and, preferably, should have had particular responsible experience in Industrial Engineering, in either manufacturing or research fields.

The post offers very great scope for new developments. The College Workshops operate both as an instructional factory and as laboratories in industrial engineering.

The basic salary scale will be £2450 by £50 to £2700, on which pension contributions will be paid. This salary will be supplemented by a very substantial amount for an outstanding man, who is able to give particular service, and for such a man may be greatly in excess of £3000 per annum.

Further particulars and application form may be obtained from the Academic Registrar. (In reply please quote 19/2/D.) C 435

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS

AIR MINISTRY require ASSISTANT MECHANICAL and ELECTRICAL ENGINEERS for design, construction and maintenance of installations on airfields, radar stations, missile bases, workshops and maintenance units for R.A.F. at home and overseas as well as certain Civil Airports. Salary: £805 at 25 to £1095 at 34 or over, thereafter rising to maximum of £1260 with increase for London and slight decrease for country districts. Appointments non-pensionable but long term. Promotion prospects. 5-day week with 4 weeks 2 days leave a year initially. Special allowance in addition to salary during overseas service. Qualifications and experience:

(i) (*a*) University degree or equivalent diploma in electrical and/or mechanical engineering with at least 2 years' apprenticeship;

or (*b*) Graduate or corporate member of I.E.E. with at least 3 years' apprenticeship;

or (*c*) Graduate or corporate member of I.Mech.E., appreciable electrical engineering experience with at least 3 years' apprenticeship;

and (ii) Have been employed for minimum of 2 years with well established engineering concern and gained wide experience in both electrical and mechanical engineering practice.

Applicants must be natural born British subjects between ages of 25 and 45. Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26 KING STREET, LONDON, S.W.1, quoting D 158/OA. C 99

MIDDLESEX COUNTY COUNCIL
EDUCATION COMMITTEE
ENFIELD TECHNICAL COLLEGE, QUEENSWAY, ENFIELD, MIDDX.

Required for 1st SEPTEMBER, 1960:
To Assistants Grade "B" in Science and Mathematics to teach these subjects up to City and Guilds Final and Ordinary National Certificate standard. Candidates should be University Graduates with teaching and/or industrial experience.

Salary within the range: £828 to £1486 per annum.

Application forms (foolscap s.a.e.) from the Principal, to whom completed forms should be returned within 14 days of the appearance of this advertisement.

C. E. GURR, M.Sc., Ph.D.,
SECRETARY TO THE EDUCATION COMMITTEE C 431

MANCHESTER CORPORATION WATERWORKS

Applications are invited for the undermentioned appointments in connection with the design and construction of treatment and filtration plant, and large service reservoirs, the reconstruction of existing reservoirs, and the reconditioning of main aqueduct:

ASSISTANT ENGINEERS (CLASS II)
£785/£1070
ASSISTANT ENGINEERS (CLASS III)
£610/£880

Applications stating (1) age, (2) education and training, (3) professional qualifications, (4) experience in the preparation of plans and construction of waterworks or other civil engineering works, together with the names of two referees, should be addressed to the ENGINEER AND MANAGER, WATERWORKS OFFICES, TOWN HALL, MANCHESTER 2, not later than 12th JULY, 1960. C 392

STATION ENGINEERS

AIR MINISTRY require STATION ENGINEERS (G.D.) and STATION ENGINEERS (MECH.) at R.A.F. and Ministry of Aviation Stations. The work of Station Engineers (G.D.) consists of installation, operation and maintenance of high and medium voltage electrical distribution systems, electrical power and lighting installations, control systems and generating plant: knowledge of heating and ventilating plant and diesel engines an advantage. Station Engineers (Mech.) are concerned with diesel power plant, steam and hot water heating systems, refrigeration and air conditioning and miscellaneous workshop plant, tools and equipment. Candidates must hold O.N.C. Elec. or Mech./City and Guilds Electrical Technicians Certificates/2nd class M.O.T. Certificate or equivalent and must also have had recognised apprenticeship with firm of good repute plus 3 years' employment in electrical or mechanical and engineering preferably on operation and maintenance of mine, factory or workshops plant and services. Preference to candidate with supervisory experience.

Salary ranges from £680 to £785 rising by annual increments to £850. Commencing salary dependent upon age, qualifications and experience. Opportunities for promotion up to Tech. Grade A, maximum salary £1565 (National rate). Pension prospects. 5-day week. 18 days paid leave a year initially. Internal training courses are provided and attendance at technical colleges by suitable candidates is sponsored. Overseas tours for which special allowances are payable in addition to higher salary. Applicants, who must be natural born British subjects up to age 55, should write stating age, qualifications and experience, to MANAGER (P.E.1), MINISTRY OF LABOUR, P. & E. REGISTER, ATLANTIC HOUSE, FARRINGDON STREET, E.C.4. No original testimonials should be sent. Only applicants selected for interview will be advised. G 885

AN OPPORTUNITY TO TEACH TECHNICAL SUBJECTS IN SECONDARY SCHOOLS

THE LONDON COUNTY COUNCIL will be pleased to consider applications for salaried appointments in its teaching service from men wishing to teach woodwork, metalwork, technical drawing or engineering subjects. To meet in particular the needs of men in industry with little or no teaching experience a full-time residential course (two weeks commencing on 29th August, 1960, and a further week in December), has been arranged at Shoreditch Training College, Coopers Hill, Englefield Green, Egham, Surrey. Accepted candidates for appointment will be paid from the beginning of the course. Burnham Scale (£558 to £1051 including London allowance)—commencing salary will depend on qualifications and experience. Qualifications needed are Higher National Diploma with at least two years' industrial experience or Higher National Certificate or an appropriate Full Technological Certificate of City and Guilds of London Institute with at least five years' experience. The fee for the course is £22 16s. 0d., £10 of which will be refunded together with reasonable travelling expenses, on satisfactory completion of the course. For further particulars and application form send a stamped addressed foolscap envelope to EDUCATION OFFICER (TS1/E/1695/7), COUNTY HALL, WESTMINSTER BRIDGE, S.E.1, IMMEDIATELY. C 426

DRAUGHTSMAN

DRAUGHTSMAN, aged 21 or over, with O.V.C. required by NORTH THAMES GAS BOARD at the TAR AND AMMONIA PRODUCTS WORKS, BECKTON, EAST HAM, E.6.

The post offers the possibility of obtaining experience in the expanding field of chemical engineering for an applicant who has has a sound mechanical training.

Starting salary will be according to qualifications and experience and the successful candidate will be required to join a contributory Staff Pension Scheme. Five-day week.

Applications, giving age and full particulars, should be sent to the STAFF CONTROLLER, NORTH THAMES GAS BOARD, 30 KENSINGTON CHURCH STREET, W.8, quoting reference EG/839. C 399

THE ROYAL TECHNICAL COLLEGE OF EAST AFRICA AND PROPOSED UNIVERSITY COLLEGE IN NAIROBI

Applications are invited for LECTURESHIPS in:
(A) ELECTRICAL ENGINEERING
(B) MECHANICAL ENGINEERING (in one or more of the following subjects):
(*a*) Strength of Materials
(*b*) Fluid Mechanics
(*c*) Theory of Machines
(C) LAND SURVEYING.

Salary scale: £1245 by £60 to £1845 per annum, entry point according to qualifications and experience. Superannuation. Child allowance £50 per annum per child (maximum £150 per annum). Passages for appointee and family (up to 4 adult passages) on appointment, termination and leave (once every two years). Rent according to quarters provided £60 to £114 per annum. Detailed applications (6 copies) naming 3 referees by 20 AUGUST, 1960, to SECRETARY, INTER-UNIVERSITY COUNCIL FOR HIGHER EDUCATION OVERSEAS, 29 WOBURN SQUARE, LONDON, W.C.1, from whom further particulars may be obtained. C 402

ENGINEERING DRAUGHTSMAN

Two vacancies have occurred at ETRURIA GAS WORKS, STOKE-ON-TRENT.

The duties involve assisting in the design and layout of structural and Mechanical plant and pipework.

Candidates should possess at least an appropriate Ordinary National Certificate and have had experience in an engineering drawing office.

The salaries for the appointments, which are pensionable, will be within the range of £629 to £813 per annum, according to qualifications and experience.

Applications, stating age, qualifications and experience, should be addressed to MR. L. W. JOHNSON, DIVISIONAL GENERAL MANAGER, WEST MIDLANDS GAS BOARD, ETRURIA GAS WORKS, STOKE-ON-TRENT, STAFFS. C 403

THURROCK TECHNICAL COLLEGE,

Woodview, Grays.

REQUIRED SEPTEMBER, 1960 (or as soon after as possible):—

ASSISTANTS, GRADE B (2) in the Engineering Department to teach either (*a*) Practical and Theoretical Welding subjects together with some machine shop calculations, science and drawing up to the Final City and Guilds Certificate standard in Welding and Fabrication of Steelwork or (*b*) Mathematics, Engineering Science, Machine Drawing and Physics up to Ordinary National Certificate standard.

Applicants should have good academic qualifications together with some industrial experience. Teaching experience would be an advantage.

Salary scale—£700 to £1150 per annum, plus additions for recognised training and graduate qualifications. The commencing salaries will have regard to previous experience.

Application forms, to be returned as soon as possible, may be obtained from the COLLEGE CLERK. C 404

GOVERNMENT OF JAMAICA ENGINEER (REFRIGERATION) PUBLIC WORKS DEPARTMENT

To design and supervise the construction and maintenance of Government air-conditioning and refrigeration installations.

Contract appointment for 3 years. Salary in range £1050—£1300 a year. Gratuity 20 per cent. of salary. Free passages. Rented quarters.

Candidates up to 50 years must have passed or be exempt from the Associate Membership examination of the Institution of Electrical Engineers *or* the Institution of Mechanical Engineers, with relevant experience or have equivalent qualification in refrigeration engineering.

Write to DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, giving full names, age, qualifications and experience, quoting BCD.112/32/024/D5. C 457

ENGINEER

An engineer is required to lead research into machinery and equipment used in the manufacture of brushes and to design apparatus for testing brushes. A graduate, or equivalent, able to work on his own will be adequately rewarded. Write: F. KIDD, c/o TEXTILE DEPARTMENT, UNIVERSITY, LEEDS, 2. C 410

MINISTRY OF TRANSPORT CIVIL ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on 1.1.60 (extension for regular Forces service, Overseas Civil Service, established civil service, and temporary Government service as Civil Engineer). Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining such membership. Experience in road and bridge construction essential; knowledge of Highways Authorities' procedure desirable. Salary (men, London) £830—£1125 according to age, rising to £1300. Promotion prospects. Write CIVIL SERVICE COMMISSION, 17 NORTH AUDLEY STREET, LONDON, W.1, for application form, quoting **S 64.** C 462

SOUTH-WEST ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART, FOREST ROAD, WALTHAMSTOW, E.17

LECTURER required as soon as possible in the Engineering Department to teach Mechanics of Fluids to Higher National and Final Degree standard. Applicants must have a University Degree and corporate membership of their professional institution.

Salary scale—£1370 rising to £1550 per annum. London Allowance of £38 or £51 per annum.

Apply by letter only (no forms) giving details of qualifications, training and experience, together with three testimonials or the names and addresses of three referees to the Clerk to the Governors at the College. C 461

CITY OF NOTTINGHAM WATER DEPARTMENT APPOINTMENT OF TWO CIVIL ENGINEERING ASSISTANTS

Applications for the above permanent, pensionable appointments are invited from Engineering Graduates, and/or Corporate Members of the Institution of Civil Engineers with five years' engineering experience, preferably with a Water Undertaking. The Department has in hand a varied programme of new works estimated to cost £1½ millions, offering considerable opportunities for gaining valuable experience. Salary, dependent upon qualifications and experience, in Grade APT. V, £1220 by £55 by £50's (2)—£1375.

Applications, with names of two persons to whom reference may be made, to ENGINEER AND GENERAL MANAGER, WATER DEPARTMENT, CASTLE BOULEVARD, NOTTINGHAM, not later than 16th JULY, 1960.

T. J. OWEN,
TOWN CLERK.

THE GUILDHALL,
NOTTINGHAM. C 460

GOVERNMENT OF JAMAICA EXECUTIVE ENGINEER (MECHANICAL), PUBLIC WORKS DEPARTMENT

Under the Director of Electrical and Mechanical Services to control the maintenance and allocation of heavy earth-moving units, vehicles and general mechanical plants; to carry out a statistical analysis of the operating cost of all equipment; to co-ordinate with the Executive Engineer in charge of Workshops in the ordering of new equipment, etc.

Contract appointment for one tour of three years. Salary range £1400—£1600 a year. Gratuity 20 per cent. of salary. House provided at reasonable rent. Free passages.

Candidates up to 50 years must be A.M.I.Mech.E. with relevant knowledge and experience.

Write to DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, giving full names, age, qualifications and experience, quoting BCD. 112/32/021/D5. C 458

METALS DIVISION

requires

MECHANICAL DESIGNERS

preferably with H.N.C. in (Mech Eng., or Civil Engineering where appropriate), and design experience in one of the following fields:—

For mechanical sections covering a wide range of plant for producing and fabricating in various forms of Copper, Aluminium, Titanium, Zirconium Beryllium and their alloys.

Rolling mills and ancillaries

Special purpose machines

Extrusion and drawing presses

Heavy hydraulics

Materials handling equipment

at

Kynoch Works
WITTON
Birmingham 6

Heat exchanger design

Pressure vessels and other fabricated structures

at

Marston Excelsior Limited
Fordhouses
Wolverhampton

Mechanical/Civil engineering

General Aircraft engineering

at

Summerfield Research Station
Kidderminster

These posts carry a good starting salary and prospects of progressive remuneration. Conditions of employment include membership of the Company's Staff Pension Fund and the Employees Profit-Sharing Scheme. Assistance may be given towards house purchase and removal expenses for married men.

Please write for an application form to the Assistant Personnel Manager (Staff), IMPERIAL CHEMICAL INDUSTRIES LIMITED, Metals Division, P.O. Box 216, Kynoch Works, Witton, Birmingham 6, quoting DO/433/ENG. C 442

INDIA

Mechanical Engineer

A leading British firm of water treatment plant engineers in London, requires a mechanical engineer to control, in their Calcutta branch, the detailed design work, manufacture and installation of their equipment at water works and in industry in India.

Applicants should be aged 27 to 35 and have qualified as Graduate or Associate Member of Institute of Mechanical Engineers.

Good background of practical workshop and drawing office experience essential. Knowledge of hydraulics and incorporation of equipment within reinforced concrete and building structures desirable. Some overseas experience advantageous.

Short training will be given in London before proceeding to India.

Apply, in confidence, with full personal details, training, experience, qualifications and commencing salary required to BOX C 432, Offices of ENGINEERING.

VEREENIGING BRICK AND TILE CO. LTD.
SOUTH AFRICA
MECHANICAL ENGINEERING DRAUGHTSMAN

Applications are invited from fully qualified mechanical engineering draughtsmen for whom a vacancy exists with the Vereeniging Brick and Tile Company in South Africa. The company is the largest manufacturer of refractories and earthenware in South Africa. Applicants should be experienced in general mechanical and structural work, also detail work in connection with crushing, screening and material handling plants.

Good prospects for advancement to Junior Engineer level for persons of suitable calibre. Total inclusive commencing salary offered is £1200 per annum. The passage of the selected applicant and his wife paid. Leave at the rate of 21 days per annum.

Applications giving full details of qualifications and experience and stating marital status, should be forwarded to:—

VEREENIGING BRICK AND TILE CO., LTD.
40, HOLBORN VIADUCT,
LONDON, E.C.1. C 467

MULLARD RESEARCH LABORATORIES

There is an interesting future for

ENGINEERS and DRAUGHTSMEN

in our Laboratories
for creative work in the following fields:

Professional Electronic Equipment.
Electro Mechanical Devices.
Engineering Technology.

ENGINEERS

These are senior appointments carrying responsibility.
Candidates should have a Degree in Engineering or be corporate members of a recognised professional institution.

DRAUGHTMEN

There are good prospects of promotion for successful candidates who should be of at least O.N.C. standard, and have completed an engineering apprenticeship with not less than four years experience in one of the above fields.
Conditions of employment are excellent including Superannuation and Life Assurance Schemes. Please apply to

MR. G. A. TAYLOR, PERSONNEL OFFICER,
MULLARD RESEARCH LABORATORIES,
CROSS OAK LANE, SALFORDS, NEAR REDHILL, SURREY. C 455

IMPERIAL CHEMICAL INDUSTRIES LIMITED

BILLINGHAM DIVISION AND HEAVY ORGANIC CHEMICALS DIVISION require for their

£30m. expansion programme

MECHANICAL, CHEMICAL AND ELECTRICAL ENGINEERS

The wide variety of engineering work at Billingham offers exceptional opportunities for a worthwhile and progressive career and for obtaining all-round experience in

DESIGN — CONSTRUCTION
DEVELOPMENT — PLANT OPERATION

and engineers in their early years are carefully trained in all facets of their profession for promotion to executive positions in management as well as in technical spheres.

Appointments are pensionable and carry attractive salaries. There is a profit-sharing scheme and assistance can be given to married men towards house purchase and removal expenses.

Applications are invited from ambitious young men aged thirty or under who hold a good Honours Degree in Mechanical, Chemical or Electrical Engineering and who have completed a course of post-graduate training. Write giving brief details of age, qualifications and experience to

THE STAFF MANAGER,
IMPERIAL CHEMICAL INDUSTRIES LIMITED,
BILLINGHAM DIVISION, BILLINGHAM, CO. DURHAM.
Quoting reference S/BB. C 466

JOHNSON MATTHEY & CO. LIMITED

have a few vacancies for young men in their engineering factories near London, who wish to make a career in Production Management.

Candidates, who should be between 25 and 30, should preferably have had a recognised engineering apprenticeship and an H.N.C. in Production Engineering. Preference will be given to candidates with some experience of production control in light engineering.—Write, giving full details of qualifications, experience, age, etc., to the

Secretary of the Company,
78, Hatton Garden,
London, E.C.1. C 418

BRITISH HYDROCARBON CHEMICALS LIMITED

have vacancies for

MECHANICAL ENGINEERS

at their rapidly expanding Grangemouth Works. Preferred ages 22/28, but older fully qualified Mechanical Engineers can also be considered. Applicants must have a degree in engineering or have been accepted as graduate members of the Inst. Mechanical Engineers. Practical training can be provided where necessary towards qualifying as A.M.I.Mech.E. Salaries will be in accordance with qualifications and experience and a non-contributory pension scheme is in operation.
Replies should be addressed to the

ADMINISTRATIVE OFFICER
BRITISH HYDROCARBON CHEMICALS LIMITED
BO'NESS ROAD
GRANGEMOUTH, STIRLINGSHIRE
C 370

CONTRACTS ENGINEERS

Nationally known company has following vacancies in their modern office in West End of London.

Contracts Engineers capable of taking full responsibility for preparation of large composite tenders and for supervision of resultant contracts.

Engineering assistants for above duties.

Candidates should have mechanical/Electrical background and be interested in commercial work. Associate membership of Institute of Mechanical Engineers and some knowledge of rubber/plastics manufacturing industry desirable but not essential.

Attractive working conditions and salaries with opportunity for advancement for suitably qualified, well-educated men. Pension scheme. Please apply in confidence with full details of age, training and experience to BOX C 424, Offices of ENGINEERING.

AN ARCHITECTURAL or BUILDING DRAUGHTSMAN

is required by
W. H. ALLEN SONS & COMPANY LTD.
for their
WORKS ENGINEERS DEPARTMENT

Experience of architectural and civil engineering design is necessary and it is desirable that applicants should have had some basic technical training.

The Company offers excellent conditions of service, a contributory Pension and Life Assurance Scheme and a comprehensive range of welfare and recreational amenities. Assistance will be given towards expenses involved in moving to the Bedford area, where appropriate.

Applications should be made in writing, giving details of age, past experience and present salary to:—

THE PERSONNEL MANAGER
(REF. 1604C/10)
QUEENS ENGINEERING WORKS
BEDFORD C 357

THE BAHRAIN PETROLEUM COMPANY LIMITED

A Power Station Engineer is required for the Power and Utilities Department of the above Company's oil refinery in the Middle East. The duties are concerned with high pressure steam boilers, condensing and extraction turbogenerators and associated plant. Experience in high voltage control, distribution and utilization would also be an advantage.

Applicants, preferably under 28 years of age, should have had a sound technical training and a minimum of two years experience iin steam operated electric power generating plants and possess at least one of the following qualifications:—

(*a*) Graduate Membership of the Institution of Mechanical Engineers.

(*b*) Graduate Membership of the Institution of Electrical Engineers.

(*c*) B.Sc. Engineering.

The commencing salary will be dependent upon qualifications and experience, in addition to which free air conditioned accommodation and a living allowance are provided. An initial kit allowance, medical attention, paid home and local leaves (passage paid for the former and generous assistance towards the latter) are also provided with participation in the Pension and Provident Fund Schemes.

Apply in writing quoting " ETS/PU "
with full particulars to

CALTEX SERVICES LIMITED,
CALTEX HOUSE,
KNIGHTSBRIDGE GREEN, LONDON,
S.W.1.

C 434

JAMES BOOTH ALUMINIUM LIMITED

ARGYLE STREET · NECHELLS BIRMINGHAM 7

require

MECHANICAL ENGINEERING DESIGNER DRAUGHTSMEN

able to work with minimum of supervision and must have at least O.N.C.

Possibility at later stage of developing into Equipment and Methods Engineer.

Good salary, contributory Pension Scheme, three weeks holiday after 12 months service. Holiday arrangements this year will be honoured. Interviews can be arranged at week-ends if desired.

C391

SENIOR PRODUCTION ENGINEER

An experienced production engineer is required to form and lead a team of specialists to engage in pre-production design of mechanisms for manufacture throughout Europe.

The team will be directly associated with a research establishment developing accessory mechanisms for the major European motor industries.

Applicants must have wide experience of economic design for mass production methods associated primarily with light presswork as well as diecasting, plastic moulding or metal sintering processes.

The position calls for occasional journeys to the Continent and therefore a knowledge of French would be advantageous though not essential.

The Laboratories are in ideal surroundings at Umberslade Park, near Hockley Heath, where working conditions are excellent. Transport is available to and from the establishment.

The post carries monthly staff status, a competitive salary, staff pension scheme, etc. Applications, which will be treated in strict confidence, stating age and full details of qualifications, experience and current salary should be addressed to:—

V. Chanaryn (52U/EG), Head of Engineering Development,

WILMOT BREEDEN LABORATORIES

Umberslade Park, Hockley Heath, Solihull, Warwickshire.

C 433

'ENGLISH ELECTRIC' Whetstone · Near Leicester

OFFERS OPPORTUNITIES TO

ENGINEERS AND DESIGNERS

IN THE FOLLOWING FIELDS

MECHANICAL ENGINEERS

1. Research and Development work on the mechanical components of reactor equipment.
2. Design of conventional plant for nuclear power stations including preparation of specifications, analysis of tenders and associated work up to the site commissioning stage.
3. Examination of the problems associated with fuel element design and development, this should particularly interest people with a knowledge of stress analysis or creep deflection of structure at high temperature.
4. The performance and optimisation studies of nuclear power stations, thermodynamics of gas circuits and steam circuits.
5. Theoretical and experimental investigations associated with heat transfer and gas flow in nuclear reactors.
6. Design and specification of the mechanical equipment associated with the core, fuel handling and control of nuclear reactors.

ELECTRICAL ENGINEERS

1. To develop special apparatus for the use of analogue computers.
2. To develop reactor control systems and electrical components of the equipment.
3. Design and contract engineering in connection with reactor auxiliary plant and reactor automatic control systems. The work involves responsibility for schemes from design initiation to site completion.
4. The design of power systems for nuclear power stations including preparation of specifications, analysis of tenders and associated work up to site commissioning stage.

* * *

The positions are permanent and pensionable, and assistance will be given towards initial accommodation.

Enquiries giving details of past experience, qualifications, age and current salary (which will be treated in strictest confidence) should be addressed to the

TECHNICAL STAFF OFFICER · DEPT. G.P.S. · MARCONI HOUSE · STRAND · W.C.2

quoting reference EG 1816H

C 463

APPOINTMENTS OPEN

SENIOR DESIGN DRAUGHTSMEN

DRAUGHTSMEN, SENIOR DESIGN, required by expanding Company for interesting and varied development work on office and printing machinery. Secure superannuated position with good salary and prospects for persons of experience and ability. Five-day week. Staff canteen. Apply MR. L. PARKER, PERSONNEL MANAGER, W. H. SMITH & SON (ALACRA), LTD., 53, PARK ROYAL ROAD, N.W.10. Tel. ELGar 6555. C 464

SENIOR DRAUGHTSMEN

SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN required for interesting work on large chemical plant installations. Experience in this type of work is desirable but not essential and applicants with general mechanical engineering experience will be favourably considered. The posts offer opportunities and salaries consistent with experience and ability. Modern offices situated in the London, E.C.4 area. Five-day week and superannuation scheme. Applications, which will be treated in the strictest confidence, giving details of age, qualifications and experience and quoting ref. LCL/E1/41 should be addressed to THE GROUP PERSONNEL MANAGER, LAPORTE INDUSTRIES LIMITED, HANOVER HOUSE, 14, HANOVER SQUARE, LONDON, W.1. C 456

DRAUGHTSMEN

DRAUGHTSMEN are required immediately to fill vacancies caused by promotion of existing Drawing Office Staff in an organisation which is expanding rapidly in order to deal with an increasing programme of capital development. Men aged 22-30, preferably with experience in chemical plant design, piping and plant layouts, who would welcome the opportunity to work on a variety of projects and are willing to accept responsibility are invited to apply.

Excellent conditions, including canteen facilities, and non-contributory pension scheme. Five-day week (36½ hr.), good salary according to age and experience. Apply in writing, giving full details of age and experience to the PERSONNEL OFFICER, MIDLAND SILICONES, LTD., BARRY, GLAMORGAN. C 451

ASSISTANT ENGINEERS

ASSISTANT ENGINEERS required for site work by engineering firm specialising in High Pressure Water Tube Boilers and Nuclear Power Stations. Preferable age would be between 25 and 30. Commencing salary would depend on qualifications and experience and there are good prospects for advancement. An out working allowance is paid when working on Site. Applicants should forward full details of their education and previous employment to BOX C 447, Offices of ENGINEERING.

ELECTRICAL ENGINEER
FOR APPLIED RESEARCH

Stewarts and Lloyds Limited, Corby, invites applications from Electrical Engineers with a degree and/or professional qualifications. The successful candidate will be engaged in applied research connected with the manufacture of steel, steel tubes and manipulated pipework. This appointment offers interesting work, varied experience, excellent working conditions and salary fully in line with achievement so far.

Corby is a new town in Northamptonshire and housing prospects are favourable. *Candidates are invited to apply in full to the Manager|Personnel,*

STEWARTS AND LLOYDS LTD.
CORBY, NORTHANTS.

C 438

STANDARDS ASSISTANT

The Standards Office of S. SMITH & SONS (ENGLAND), LTD., require a YOUNG ENGINEER, aged approximately 20 to 24 years educated to at least O.N.C. standard. Although Drawing Office experience is desirable, a knowledge of Standardization is not necessary as training will be given in all facets of the job. The work is interesting, covers a wide field and requires adaptability. The ability to write clearly and concisely is essential.

Applications will be treated in strict confidence and should be made in writing to:—
THE STAFF MANAGER,
S. SMITH & SONS (ENGLAND) LTD.,
CRICKLEWOOD, LONDON, N.W.2.
quoting reference SM. 316.

C 440

GRADUATE ENGINEER

GRADUATE ENGINEER: If you have a good honours degree in mechanical or electrical engineering and are about to complete your post-graduate apprenticeship and would like to make a career with the Commonwealth's largest glass manufacturing organisation, you are invited to write about yourself to the Personnel Officer (Graduate Recruitment), Pilkington Brothers Limited, St. Helens, Lancashire. Initially you would be a Technical Assistant in the production department of the works manufacturing toughened glass doors, wall cladding and many other forms of toughened glass. After training in production methods you would be engaged particularly on method development. You would have ample scope for exercising your initiative and later you would have opportunities for promotion in maintenance engineering or production departments, in this country or overseas. C 437

TECHNICAL ADVERTISING AND PUBLISHING

U.K. business manager to handle leading technical and engineering journals for syndicate of American publishers now establishing European division. Applicants must have proven sales and technical background in one or more of the following fields:—Petroleum, chemistry, marine engineering and ship building, railways, steel production and metal working, metallurgy, industrial power equipment. Some knowledge of modern industrial advertising, sales promotion and merchandising desirable but not essential.

Age 30 to 45. Excellent salary. Expenses and participation in profits.

Submit detailed qualifications and experience with photograph if possible to BOX 000. Interviews in England beginning about June 10, 1960.
Offices of ENGINEERING C 468

SENIOR ENGINEER

SENIOR ENGINEER required to take charge technically and promote sales of ELECTROSTATIC PRECIPITATION plant with particular reference to steelworks fume problems. Interesting position requiring previous experience and initiative which will be appropriately rewarded. Write BOX C 427 Offices of ENGINEERING.

LAYOUT DRAUGHTSMEN

DESIGN AND CHEMICAL PLANT LAYOUT DRAUGHTSMEN required. Structural Steelwork or Instrument Installation experience an advantage. Excellent conditions in new Drawing Office. Superannuation and Life Insurance Scheme. Canteen facilities. Apply in writing, giving full details of past experience, and salary required to:—
CHIEF DRAUGHTSMAN, NORDAC LIMITED, UXBRIDGE MIDDX. C 446

DRAUGHTSMAN

DRAUGHTSMAN required in London Office of Consulting Engineers for plant layout work in connection with Hydro-Electric Power Stations. Apply stating age, experience and present salary to KENNEDY & DONKIN, 12, CAXTON STREET, S.W.1 QUOTING REFERENCE HRM. C 419

ENGINEERS

ENGINEERS for inspection of cranes and lifting plant. Must have drawing office experience, design of cranes, also National Certificate in Mechanical Engineering. Essex, Warwickshire and Liverpool areas. Starting salary £800 per annum. Non-contributory pension—permanent. Apply: ENGINEERING DEPT., GENERAL ASSURANCE CORP., LTD., ALDWYCH, LONDON, W.C.2. C 406

ENGINEER

ENGINEER required for examination and reporting on chains, ropes and lifting tackle. Should have experience in the making of such plant. Essex area. Starting salary £800 per annum. Write BOX ENG. 586 LPE ROMANO HOUSE, 399/401, STRAND, LONDON, W.C.2. C 405

DRAUGHTSMAN

DRAUGHTSMAN required to handle contracts on Small Water-Tube Boilers including design and detail work. EAST LONDON AREA. State age, salary and experience.—BOX C353, Offices of ENGINEERING.

DRAUGHTSMEN (SENIOR)

DRAUGHTSMEN (SENIOR) required immediately and early autumn to cope with increasing demand for industrial air conditioning, fume removal, dust collecting plants, etc. Excellent conditions, top salaries, pension scheme, etc. Write BOX C 428, Offices of ENGINEERING.

ENGINEER

ENGINEER having technical knowledge of heat transfer problems with special reference to evaporative type water coolers required to augment present department unable to cope with increasing demand. Write BOX C 429, Offices of ENGINEERING.

CHIEF INSPECTOR

A leading machine tool maker in the Midlands invites applications for this important post.

Applicants should preferably be not more than 45 years of age, with a professional qualification or equivalent and with practical knowledge of modern inspection methods.

The person appointed will be directly responsible to the Works Director for the maintenance of a high standard of quality control.

The salary will be commensurate with the importance of this key position.

Applications, which should be as detailed as possible, should be sent marked Private and Confidential to BOX C 411, Offices of ENGINEERING.

AN APPRENTICE TRAINING SUPERVISOR

is required by STEWARTS AND LLOYDS LIMITED for their Works at CORBY, NORTHAMPTONSHIRE.

The supervisor will be on the staff of the Area Training Officer and will be responsible for the general supervision of some 300 apprentices of all grades up to university graduates. He will also share in the general activities of the Training Department.

Essential qualifications are a keen interest in the development and training of young people, a mechanical engineering qualification not lower than Higher National Certificate and a knowledge of the technical education system and of the requirements for the training of engineers. Age not less than 30 years.

Experience of university life and education, and some knowledge of electrical engineering and/or metallurgy are desirable.

Application forms, which should be returned within a fortnight of the appearance of this advertisement, may be obtained from the

ASSISTANT DIRECTOR OF TRAINING,
STEWARTS AND LLOYDS LIMITED,
BROAD STREET CHAMBERS,
BIRMINGHAM 1.

C 454

COMPANY REPORT

ELLIOTT-AUTOMATION GROUP

SUMMARY OF RESULTS FOR 1959

Group Profit before Taxation	**£1,015,630**
Group Profit after Taxation	**£548,875**
Dividends	**£262,910**
Profit of year retained in business	**£285,965**
Total Issued Capital and Reserves	**£9,122,826**
Net Current Assets	**£6,858,478**

Copies of the full Report and Accounts can be obtained on application to the Secretary

ELLIOTT-AUTOMATION LIMITED
CENTURY WORKS, LEWISHAM, LONDON, S.E.13

C 409

ADVERTISEMENT RATES

'Engineering' Appointments Section

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates: per page (12 in. by 9 in.) £100
half page £54
quarter page £29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates: per page (12 in. by 9 in.) £100
per half page £54
quarter page £29
per single column inch .. .. £2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line .. .. 4s. 6d.
(Minimum charge 18s.)

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26; 20 per cent. on 52.

BOX NUMBER: 2s.

Company Meetings

Quarter page, £29; half page, £54; full page, £100.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Companies

Intense Activity, Energy and Gay Expansion

THERE is no lack of variety about the activities of the widespread BELL'S ASBESTOS Group.

At the centre of the group, BELL'S ASBESTOS AND ENGINEERING found that the improved economic climate did not make any effect until the end of the year. It was not able to improve on the home sales of the previous year. Overseas it experienced a revival in South American business and maintained sales in Western Europe.

The group's chairman, Mr. Claude Bell, makes the now familiar point that increased costs, unmatched by any increase in selling prices brought a decline in profit margins.

Profit for the year, before tax, for the group was £580,009 (against £577,217 in 1958).

In the RONALD TRIST Company the output of the mechanical engineering works was increased to cope with increased demands for steam-operated boiler controls, liquid level switches and vertical electric boiler level controls and alarms.

The company keeps a wary eye on the business of diversification but it had made some useful sallies in this direction. A notable example is with the VENETIAN VOGUE Company. Producing Venetian blinds, now with an "invisible" tape made from Terylene, the company has outgrown one factory in Scotland and moved to another twice the size, which has now been fully utilised. The turnover and profits go on breaking records and the chairman enthusiastically calls this—"a story of gay and constant expansion."

Bell's and Cie, the Portuguese company, increased its turnover while in Holland C. W. TODD VAN 1890 N.V. suffered from the sharp decline in ship repairing while keeping up its general industrial sales.

From Polyethylene to Kitchen Sinks

From the 60 mile, 18 in oil pipeline from Milford Haven to Llandarcy, South Wales, to the highest block of flats in Scotland or the trial borings in the English Channel for the Channel Tunnel study group, the activities of the GEORGE WIMPEY Company are diverse and widely spread.

They are also profitable, as an increased profit last year of £1,510,928 after tax, against £1,168,028 in 1958, shows.

A growing sector of the company's affairs are the mechanical, electrical and chemical engineering departments. The SHELL Company recently contracted with Wimpey for a £5 million high pressure polyethylene plant in Lancashire, for which the company will do the civil engineering, building, mechanical and electrical work. At Fawley, near Southampton, construction of the £2½ million ethylene oxide plant for UNION CARBIDE is substantially complete. The same company have asked Wimpey to build a £2 million extension to the polyethylene plant built by them at Grangemouth.

In house building, the company is able to point to 132,000 homes built since 1947. In Glasgow, Wimpey are to build 453 flats, with shops and garages, at Royston. The majority of this scheme is contained within three 20 storey blocks which will be the tallest blocks of flats in Scotland.

The company maintains an impressive central laboratory whose staff have conducted numerous site investigations for public authorities and consulting engineers.

The laboratory's marine operations have included borings below the sea bed for oil and rock cores, underwater cement grouting, geophysical surveys and meteorological observation. The construction of hydraulic models has helped in the design of several major harbour works, nuclear power stations and hydro-electric schemes.

Disastrous Conditions in Overseas Civil Contracts

From building two houses at Blackpool in 1921 Mr. Frank Taylor has expanded and ploughed back until in his annual statement as chairman and managing director of TAYLOR WOODROW Limited he is able to announce a turnover last year of £29½ million, more than £2 million above that in 1958.

The profit after tax of £702,000 was more than five times the profit of 1954 (£130,000). An equally lavish rise has occurred in the amount of money ploughed back into the business each year. From £84,000 in 1954 this has increased to £380,000 last year.

Healthy as all these figures no doubt are, Mr. Taylor laid out a picture full of serious difficulties now and in the future. Competition at home has become increasingly severe. In every case where tenders are called for the competitors find that one or two contractors put forward figures below the actual cost.

Presumably those who do this are making the sacrifice for the value of having their name up over the work if they get the chance to do it.

Mr. Taylor castigates these below-cost tenders as unsatisfactory, pointing out that since the contractor has to produce work up to the specification he is entitled to a fair price. The controversy now raging over the often astronomical price of building land finds its reflection here. The extremely high price demanded for what building land does become available makes it difficult to produce first class well planned homes for sale at a price people can afford.

The building land shortage has adverse side effects. It makes for bad planning and uneconomic building, increases prices and cuts down the size of homes.

In at least one field of the group's home operations Mr. Taylor is able to find unqualified success. The subsidiary MYTON Limited, has begun work on two new contracts, among others, the Zidpark automatic car park at Southwark Bridge, and Hillgate House, near St. Paul's, plans for both of which have been favourably commented upon.

The foreign activities of Taylor Woodrow companies provide a commentary upon the countries concerned. In Canada, for instance, the contracting company have pulled off a contract to build the new FORD MOTOR Company head office in Toronto, at about $5 million. Less happy is the position of the property company, MONARCH INVESTMENTS Limited which has come up against the extreme shortage of mortgage money and the Canadian version of credit squeeze. The result is that it has both offices and flats to let.

Contracts for overseas work are the subject of very severe competition and many of the contract conditions imposed, says Mr. Taylor, are both unfair and disastrous. Foreign employers are seeking longer periods of credit with lower and lower interest rates. This has produced a battle to see who can lend the most money on contracts and carry out the work regardless of financial losses incurred. Despite the discouraging outlook Taylor Woodrow directors and executives are active around the world looking for profitable work for the group.

Going no further than Dungeness the company is responsible for the first lighthouse to be put up in Britain for 50 years.

3-D Microscope Makers Bought Out

R. AND J. BECK, an old established firm of optical instrument makers, have been acquired by GRIFFIN AND GEORGE.

Beck, with works at Watford and in Kentish Town, produced the new 3-D image microscope designed at the Cambridge Psychological Laboratory. This microscope is now being put to work in examining how the brain cells are physically related.

Griffin and George are not changing the name of the Beck business or its board. Four new directors will join the Beck board, representing the parent company.

Helicopter Promotion for Harvest Brigadiers

The world wide agricultural machinery makers MASSEY-FERGUSON, who appear to have no particular difficulty in breaking their own sales records at regular intervals, in fact put a good deal of effort and imagination into it.

One of the most recent examples was

the helicopter tour around the company's United Kingdom distributors.

Leading the team was Mr. L. H. Pomeroy, the marketing director of Massey-Ferguson (UK). Mr. Pomeroy is on the left of the picture, Mr. A. A. Thornborough, president of Massey-Ferguson on the right.

Why the helicopter and not an executive's light conventional aircraft? The answer is that the time schedule of the ten day tour was calculated to the minute. Twenty-one conferences on nine working days is not a routine that makes lengthy road journeys from airports at all desirable.

From Exeter the party, including service, advertising and regional executives, moved across Britain, winding up in Perth. En route it took in meetings at Woburn Abbey and Penshurst Place, as well as rather less aristocratic venues.

Distributors' staff were given the latest information and carefully worked out briefing on the company's special scheme for providing help to farmers as the farm year moves up to the peak activity of harvest time.

Nuclear Consortia Now Down to Three

Close upon the announcement of the reduced nuclear power programme comes the announcement that ATOMIC POWER CONSTRUCTIONS and the GEC-SIMON-CARVES ATOMIC ENERGY GROUP are to merge.

GEC's managing director and vice-chairman, Mr. Arnold Lindley, will be the chairman; Colonel G. W. Raby, managing director of APC, will be managing director of the new company which is to be set up.

There will now be three consortia competing for home nuclear power stations, which the recent White Paper indicates will be ordered at a rate of only about one a year. The other competitors are the NUCLEAR POWER GROUP and the ENGLISH ELECTRIC-BABCOCK & WILCOX-TAYLOR WOODROW association.

The companies of the Atomic Power Constructions group are CROMPTON PARKINSON, FAIREY AVIATION, INTERNATIONAL COMBUSTION and RICHARDSONS WESTGARTH and there are links with TROLLOPE AND COLLS and HOLLAND & HANNEN AND CUBITTS.

The new merger, which must have been at an advanced stage of agreement before the release of the Government's White Paper, is further evidence of the way in which the prospects of the market for nuclear power generation have not lived up to early expectations. The increasing efficiencies being achieved with conventional stations, of which Blyth A is a good—though soon to be superseded—example, and the present abundance of coal does not suggest that Government policy, having swung away from the nuclear stations, will at all quickly swing back again.

At a rate of ordering of only one nuclear station a year it follows that if the consortia are to be at all profitably engaged the greater part of their activities will have to be in the export markets. If this hurdle is successfully passed then the heavy electrical industry will benefit substantially. If the going is as difficult as it looks likely then more losses may be inevitable.

A Good Year for Manhurin

Since Elliott-Automation are to be represented on the board of Manufacture de Machines du Haut-Rhin, it is interesting to note that that concern enjoyed a 4 per cent increase in its turn-over last year.

Almost a third of its output is exported. Like E-A in the United Kingdom its capacity is fully engaged and the company is expanding.

Two of the three Manhurin subsidiaries increased turnover notably on the previous year, one by 8 per cent and the other by 15 per cent.

Reducing the Error in a Hobbing Machine

A device has been developed which continuously measures the transmission errors of a gear hobbing machine. A feedback servo-mechanism compensates for the errors.

TO OBTAIN optimum efficiency and reduced size steam turbines need to be operated at high speed and, because the driven members in most cases have to run at relatively low speed, a speed reduction gearbox, usually two stage, has to be incorporated. In turn, the quiet and safe continuous running of this gearbox at outputs up to 22,000 h.p. necessitates accurately cut gears with a high precision of pitch, correct tooth form and high grade surfaces. Most of these gears are cut on purpose designed hobbing machines.

The table or work spindle of these machines is driven by a worm and wormwheel, so that the accuracy of the gears produced is based on the accuracy of the driving gear. British Standards Specification 1498 (1954) "Gear Hobbing Machines for Turbine and Similar Drives" defines the accuracy required of the machines and, in particular, the traverse pitch errors of the master worm wheel, the master worm and test gears cut on the machine. To date, the pitch measurement of the spur test gear cut on the machine has been the only acceptable method for checking the transmission accuracy. It is not a continuous method and produces only graphic results.

The David Brown Emisyn System on show at the current International Machine Tool Exhibition introduces a method of continuously measuring the transmission errors as the machine is running and a feedback servomechanism to compensate for the errors. The accuracy of a machine fitted with this equipment is no longer dependent on the accuracy of the master worm wheel. Accuracy is now derived from the measuring system, and a 3·5 metre machine will produce a 100 in diameter gear with a maximum cumulative error of 0·0012 in. The British Standard allowance for a 100 in test gear is three times greater at 0·0036 in.

BASIS OF SYSTEM

Basically, a gear hobbing machine consists of a main motor and a gearbox with three output shafts which drive the work table, the hob and the hob saddle. The speed ratio of the three shafts which determines the number of teeth cut and the helix angle is established in the gearbox. The pitch and accuracy of the gear cut is based on the accuracy of the transmission from the worm drive shaft to the work table. The Emisyn system has been introduced to measure and correct this transmission.

On the 3·5 metre machine, the speed ratio from the worm drive shaft (input) to the work table (output) is 450 : 1. Errors in the elements of this drive produce lack of synchronism between the input and output. The measuring system consists of a synchro-resolver driven from the input and an Inductosyn attached to the table. The split field motor, gearbox and special differential mechanism injects the corrections to the table drive. Fig. 1 shows a block diagram of the system.

The resolver is driven from the worm drive shaft through a 450 : 180 gear reduction, which is necessary in order to match its output to the Inductosyn. It produces two electrical outputs, one proportional to the sine of its positioned angle and the other proportional to the cosine of that angle. Thus, two voltages are produced whose amplitudes vary sinusoidally as the synchro rotates. An output of one cycle corresponds to one complete revolution of the resolver. These voltages are applied to buffer amplifiers which modify the impedance of the signals and apply them to the stator of the Inductosyn.

When the resolver output voltages are applied to the Inductosyn stator, there is no output from the rotor provided that the Inductosyn and resolver are always in synchronism—that is, if there is no error in the table drive gears. If an error does exist, the resolver and Inductosyn will not be in synchronism, and the Inductosyn rotor gives a voltage output.

This voltage is amplified in a balanced servo-amplifier and made to energise the fields of a split-field motor in such a way as to rotate the motor so that the error is corrected. The correction servo-system is stabilised from a d.c. tacho-generator driven by the servo-motor.

MEASURING ELEMENT

The measuring of position is effected by means of a rotary Inductosyn mentioned already and shown in Figs. 3 and 4. It consists of two glass discs, one of which is attached to the rotating table and the other to the base casting of the machine. Each disc has a winding photo-engraved on it. The winding of the rotating element is continuous and is in the form of end connected radial lines spaced one degree apart. The stationary element has 16 separate windings similar in form to those of the rotor. Adjacent

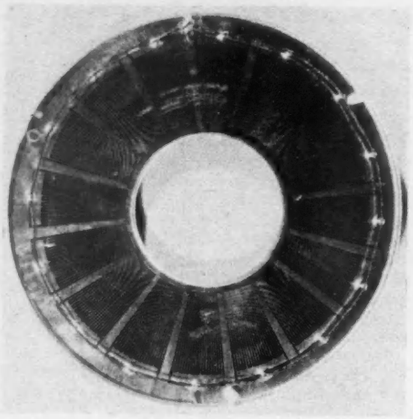


Fig. 3 The stator of the Inductosyn.

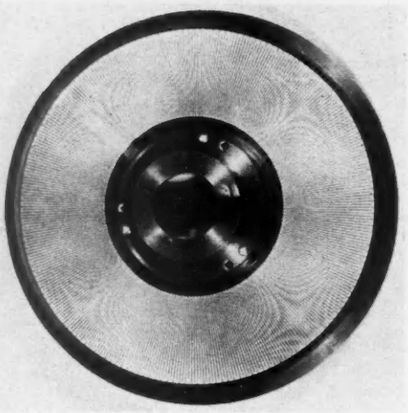
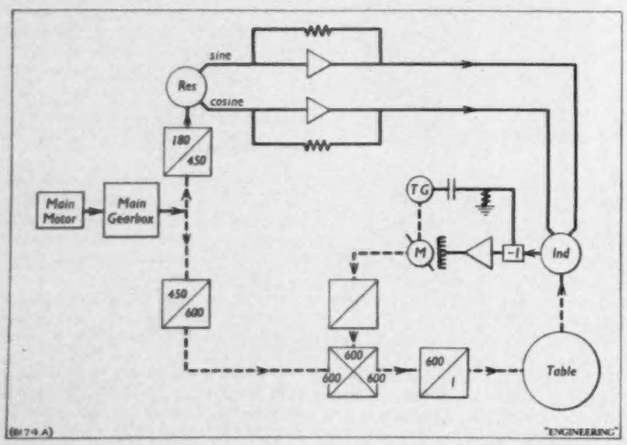
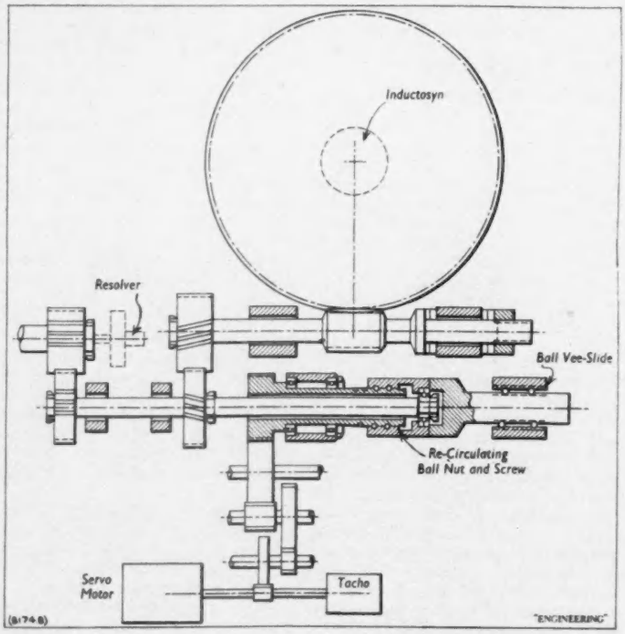


Fig. 4 The rotor of the Inductosyn.

Fig. 1 (below) A block diagram of the David Brown Emisyn accuracy control system.

Fig. 2 (right) The servo-correcting mechanism.





windings on the stator are displaced relative to each other by half a degree, and are connected together to form two complete windings.

If particular voltages are applied to the stator windings, an output voltage will be obtained from the rotor windings which varies sinusoidally as the rotor and stator are moved through an angle of two degrees relative to one another. If the values of the stator voltages are altered, the angle at which the rotor gives zero output will alter, and thus, for every combination of stator voltages, there is one particular angle within the two degree Inductosyn cycle at which the rotor output is zero. This and the machine input voltages are generated by a synchro-resolver, and energise the Inductosyn stator. The rotating table is servoed continuously to follow the rotor zero angle.

SERVO-CORRECTING MECHANISM

Because of the high magnification produced by it, the principle of sliding one helical gear axially with respect to its mating gear so that the other rotates slightly, has been adapted for the differential mechanism of this system. The layshaft in the worm drive shown in Fig. 2, has a spur gear at one end mating with a wide spur gear on the main gearbox output shaft. The pitch of the main worm is $\frac{1}{2}$ in and the helical gears are 10 in in diameter with 9° helix angle, so that an axial displacement of 0·1 in produces a correction of 0·00025 in at the master worm wheel. With this magnification of 400 : 1, the displacement only needs to be approximate.

The axial displacement is produced by a frictionless, backlash-free recirculating ball nut and screw. An extension of the layshaft is located in the nut by a duplex bearing, and the nut is restrained from rotating by a ball V-slide. Thus, when the screw is rotated, the layshaft will be displaced axially. The screw, which has a $\frac{1}{2}$ in pitch, is driven through a spur gearbox by a 100W servo-motor. The mechanism is capable of correcting at a rate of 0·0004 in per sec, which is adequate for this type of machine.

Converting from Batch to Flow Production

The first stage of a £1¼ million extension and reorganisation scheme has just been completed by Electrolux Limited at its refrigerator and cleaner factories at Luton. Refrigerator production has been increased by 75 per cent and cleaner production by 25 per cent. This makes the factory one of the largest producers of refrigerators in Europe, capable of producing nearly 3 units a minute.

In addition to the extensions, which were begun in 1958, the production areas of the refrigerator factory have been reorganised and streamlined to allow for new methods of flow production to replace the batch processes carried out previously. The opportunity has also been taken to rationalise production methods and to introduce the latest methods of mechanical handling to facilitate the flow of work through the factory and to enable it to meet the greatly increased demand for refrigerators. Production has been maintained during reorganisation.

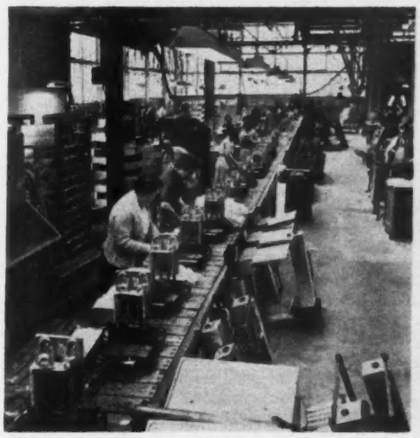
New plant installed includes a large extension to an existing electrostatic painting plant—using the Ransburg No. 2 process—which was installed in 1954. With the increased use of plastics, three new deep-draw vacuum moulding machines have been installed to produce plastic interior cabinet linings. There are other machines for forming complete door linings.

To provide greater production capacity, a new pre-treatment plant has also been installed in the paint shop, new conveyor systems have been added, two assembly lines have been extended, the stillage method for storage of steel tubes has been introduced, and increased use is being made of mechanical handling and palletisation. The use of storage containers has been extended to include such items as glass wool used for insulation. Many containers are now filled by component manufacturers, delivered to the factory and stored until required.

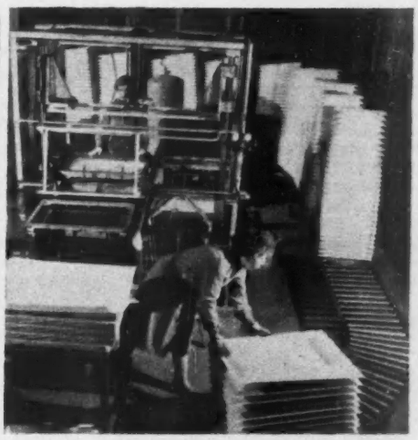
In addition to the new plant and production methods, the cooling unit shop has been completely reorganised and, to cope with the need for increased production, a new continuous processing plant has been installed for pickling, galvanising, painting and filling in one continuous process. The system used generally throughout in the shop has been changed from one providing the manufacture of details in batches to one continuously producing components for complete units.

There are two production lines in the refrigerator works, one for small models and one for large. Basically they stem from the main raw materials stores, one containing the steel tubing and components for the cooling units, the other containing the sheet steel and components for cabinets. Both flow lines run independently until they meet at the final assembly lines.

Steel tubing is taken from the stores in stillage containers, each holding about 3 tons of tubing cut to the length required, and carried by gantry crane to the cooling unit shop. Here, the tubing is degreased, shot blasted and bent to shape before joining chain conveyors leading through the machine and welding flow lines. Groups of components are then added to these



Fitting insulation to completed absorption units.



The vacuum forming of door linings.

conveyors as they continue towards the final welding point.

When each absorption unit is assembled and welded it is given the first of a series of leak tests carried out at each successive stage of production. The next leak test is carried out on each unit when it has passed through the new processing plant where units are conveyed through an acid pickling plant, and before they travel through an oven which dries them ready for hot-dip galvanising. After galvanising the units are transferred to the painting conveyor system which dips them into a large paint tank and carries them through the stoving oven before they are evacuated and filled with refrigerant. They are then transferred to a slat conveyor for final comprehensive leak tests on all welded joints, after which the boiler cases are filled with slag wool insulation. This conveyor carries the units into a large testing room, where they undergo extensive operational tests before joining a transfer conveyor system which carries them either into the stores or to the main cabinet assembly lines.

The assembly of cabinets for all sizes of refrigerator follows the same system of continuous flow and begins, essentially, with the storing of the sheet steel outer casings, the storing of inner casings and the vacuum forming of plastic linings.

Doors are formed from sheet steel in one operation in power presses and cabinets are formed in large V-benders. They are stored separately preparatory to being conveyed in complete sets of main components to the bonderising and drying plant. The sets of main cabinet components are then transferred to the paint conveyor system which carries them through the electrostatic painting plant where they undergo the complete processes of priming, rubbing down, stoving, top-coating and final stoving. After inspection, the outer casings and doors—according to the size of refrigerator

The final assembly line.

being produced—are placed on slat conveyor systems which are joined along their length by chain conveyors bringing up the plastic linings, and at this point the systems become the two final assembly tracks, and are joined by another conveyor system carrying the finished absorption units.

On the final assembly tracks, the cabinets are lined with glass wool insulation; inner casings and fully assembled doors are fitted and the units are installed. The next stage is the fitting of shelves, radiator assemblies, ice trays and other features and, finally, a cabinet sealing test is applied followed by a high voltage insulation test. After final inspection, each cabinet is packed before passing on to the stores and dispatch section.

Power and "Top Up" Steam for Steelworks

Increasing steam demands at Margam steelworks have been met by the installation of a super-high-pressure boiler and a back-pressure turbo-alternator exhausting to the existing steam mains.

EXTENSIONS to the Margam and Abbey Steelworks of the Steel Company of Wales created a demand for an additional 200,000 lb per hour of steam for driving turbo-blowers, electric generation, and for process work.

The existing plant consisted of two power stations, with water tube boilers working at 625 lb per sq. in and 820° F, and interlocked by a 620 lb steam main. Two schemes meeting the increased steam demand were considered. A conventional water tube boiler of 200,000 lb per hour, steaming at 625 lb per sq. in, could have been installed, together with an axial flow condensing turbo-blower. Alternatively, a Benson " once-through " boiler and a back-pressure turbo-alternator delivering 200,000 lb of steam per hour into the existing steam system was considered. This latter proposal was adopted for several reasons, of which electric power requirements and operating efficiency were of prime importance. In the existing plant the total generating capacity was about 30 MW—about half the normal demand and one-third of the maximum demand. The installation of a critical-pressure boiler and back-pressure turbo-alternator made it possible to produce a further 9·5 MW of power for works use, thus effecting a considerable saving. A study of the thermodynamics showed that 3,300 lb per sq. in and 1,060° F was about the optimum operating condition when considering a total steam flow of 240,000 lb per hour, and this specification was adopted. On the basis of operating cost, a comparison between the 3,300 lb 1,060° F installation and the 625 lb 820° F alternative showed that the high-pressure boiler and turbo-alternator supplying " top-up " steam would be both practicable and economic. A factor which assisted in reaching the decision was that several of the existing power station workers were trained to a very high technical standard.

The plant installed is the first Benson boiler in Great Britain, and powers what is believed to be the highest-pressure turbine ever manufactured in this country.

ALTERNATIVE FUELS

Designed and built by Simon-Carves Limited, Stockport, the boiler is rated at 240,000 lb of steam per hour, at a pressure of 3,300 lb per sq. in and 1,060° F, with reheat to 836° F. Blast furnace gas is the fuel normally used, but to allow for variation in gas supply due to demands from other parts of the plant or for other causes, the boiler is arranged to burn either blast furnace gas, oil fuel or any mixture of the two. A pilot oil flame equal to approximately 10 per cent of the total fuel burnt is provided, and any reduction in blast furnace gas supply is compensated for automatically by an increase in the fuel oil flow.

The Benson boiler is of the forced circulation type, in which the feed water is heated, evaporated and superheated in a single passage through a number of tubes in parallel. There are no drums, and the heating surfaces are exclusively small bore tubes (1¼ to 1½ in outside diameter), connected to each other and to the headers by welding. Benson boilers can be built for operation at pressures up to about 5,000 lb per sq. in, and the detailed design depends upon the pressure and temperature. At Margam the boiler has four passes, each directly behind the other.

In the first, or combustion, zone there is the radiant superheater, with the first evaporator above it, followed by the final convection superheater in two sections. Above this superheater is a further evaporator in three sections. This is the transition zone, where the change of state from water to steam takes place. The connecting tubes between the two sections of the final convection superheater are crossed, as are also the connection tubes between the second and third sections of the evaporator. Reheater sections form the second pass and the secondary economiser sections arranged in parallel comprise the third pass. In the fourth, or rear pass, are the secondary air heater, the primary economiser and the primary air heater.

The total resistance of the boiler and superheater circuit is overcome by the feed pump delivery head, and this governs the final steam pressure. Variation in this delivery head enables the boiler to be operated at less than design pressure, an advantage when starting up.

Control can be operated fully automatically, or auto-manually; in the latter case the controls are operated electrically from the boiler supervisor's desk.

The turbo-alternator was designed and built by Richardons Westgarth (Hartlepool) Limited, and is designed for a terminal output of 9,250 kW when supplied with 240,000 lb of steam per hour

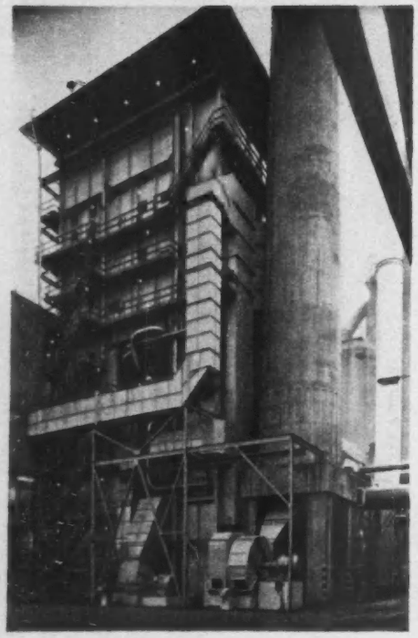


Fig. 1 (left) Steam is generated at 3,300 lb per sq. in in the Benson boiler at Margam. It is the first of its type to be made in Great Britain.

Fig. 2 (right) The boiler is arranged with four passes and can be fired on blast furnace gas, oil fuel, or a mixture of both.

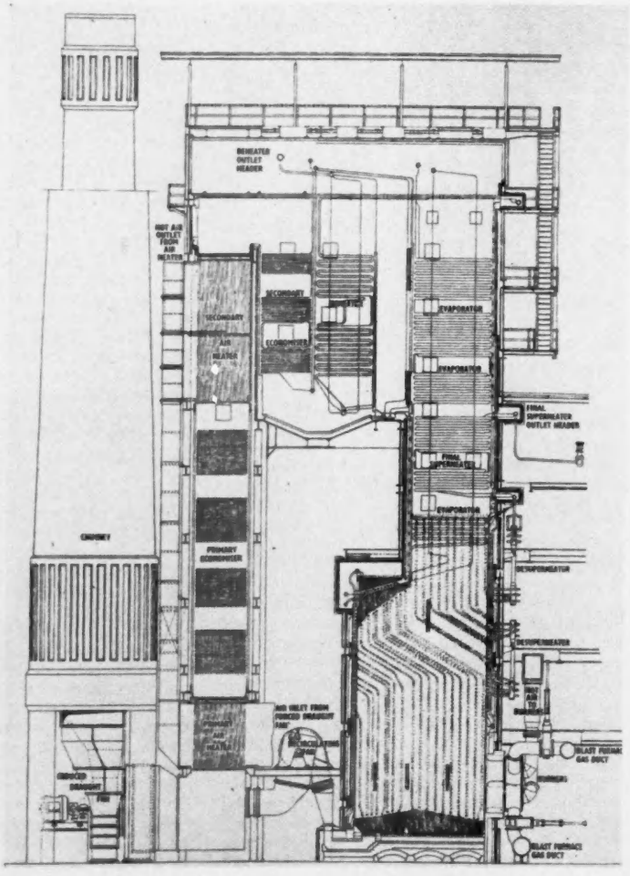
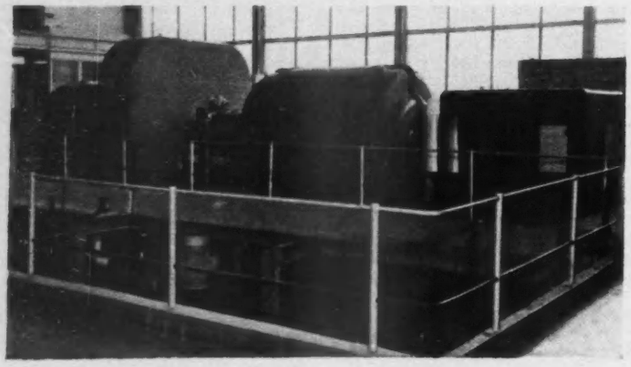


Fig. 3 (below) Steam from the boiler is used in what is believed to be the highest-pressure turbo-alternator ever made in Britain.



at 3,000 lb per sq. in and 1,050° F, and exhausting at 650 lb per sq. in, 670° F. The turbine rotor runs at 9,500 r.p.m., and drives the alternator at 3,000 r.p.m. through a W. H. Allen epicyclic reduction gear. Double-walled construction is used for the turbine cylinder, the total weight of the inner and flanged outer cylinder being 4½ tons. Steam is received at a strainer on the centreline of the machine and connected to combined stop and emergency valves, each of which is in an integral chest with two nozzle valves. A single row of impulse blades on the rotor is followed by 14 rows of reaction blading. The inner cylinder is divided at the horizontal joint and held together by a series of shrink rings. Conventional design is used for the outer cylinder, in which the inner component is supported by four palms cast integral with the bottom half. Speed and load governing are by a centrifugal governor. An Askania regulator is also provided so that the load can be governed by the boiler pressure. Double helical gears are used in the speed reducer between the turbine and the alternator, so arranged that the load is shared equally between the planet wheels, and the primary and secondary shafts lie on the same axis, with different directions of rotation. A fabricated steel casing houses the gears, and it is split along the horizontal centreline so that the internal assembly can be removed without disturbing either the high-speed or the low-speed shaft.

The alternator is of the standard turbo type, with direct-coupled exciter, and can deliver 9,500 kW continuously at 10,500/11,500V, 50 cycles per second when running at 3,000 r.p.m. It is of entirely conventional construction, having a fan mounted at each end of the rotor, together with a closed circuit air cooler.

Water Costs Money—How to Save It

Though rainfall in Great Britain is quite well distributed throughout the year, a water shortage could easily develop. There are several reasons for this possibility. Rain is the source of all natural fresh water, but although the rainfall is distributed reasonably evenly between the seasons, it is far from evenly distributed geographically.

A sub-committee of the Central Advisory Water Committee has investigated the growing demand for water and the means of meeting it, and in their report* the committee state that for the near future—up to 1965—development schemes already prepared by the water undertakings are sufficient to meet the likely demand. Looking further ahead, the conclusion is that there need be no shortage of water in any part of the country, provided that certain development essentials are met. These include schemes for increased supplies, prepared well in advance of demand, the location of industries using large quantities of water with the supply position in mind, and "... the readiness of all concerned to regard water as a valuable commodity ...".

Mains water for industrial purposes is cheap. At an average price of 5*d.* per ton delivered to the consumer's factory, there is probably no commodity in industry which can approach it for low cost.

INCREASING CONSUMPTION

The Water sub-committee found that, taking a cross-section of districts of widely different characteristics, total consumption over the past 30 years or so has been rising by about 2 per cent. per annum; the estimated national rise for the ten years 1955 to 1965 is 2·3 per cent per annum.

In areas which are predominantly industrial, consumption figures show an impressive rise. The City of Birmingham Water Department, for example, has a statutory area of supply of 195 sq. miles, with an estimated population of 1,245,000. In 15 years industrial consumption has risen from 14½ to 27½ million gallons a day. similar conditions apply in the supply area of a neighbouring authority, the South Staffordshire Waterworks Company. This authority has both industrial and rural districts within its supply area of some 467 sq. miles, and serves a rather smaller population than Birmingham. Between 1950 and 1959, industrial water consumption in the Company's area has risen from 14·08 to 19·57 million gallons a day.

Such is the picture in two water authorities' areas. With variations due to local conditions it is much the same everywhere there is an appreciable amount of industry. There is, of course, also a growing domestic demand for water in all parts of the country, but this is a separate problem, to be dealt with by different means. It does not directly concern the industrialist except in so far as he can, as a private individual, take care to prevent waste.

There is a further aspect of the rising demand for water which does not concern the supply authorities, but is of importance nationally. Most of the water used by industry has to be disposed of after use—some evaporates while it is in the factory—but by far the greater part has to be conducted away. In a few instances it is possible to let the water run away to a stream or river, but in most cases it passes to the sewers. "Down the drain" is such a simple and effective way of getting rid of water that it is easy to forget that somebody has to provide and maintain the drains and somebody has to pay for this work. Mains drainage is the responsibility of the local authority, but it is the ratepayers—including industrialists—who pay for them.

WATER DISPOSAL

More water into factories means more water out of them, and into the sewers. There are, of course, legal requirements restricting the amount of contaminants which pass into the sewers with the water, but this question of industrial effluents is a separate one. It does not alter the fact that even if all the water used in factories were passed into the sewers in a state of purity equal to that of a public supply—and some of it is—the sheer volume would still be a source of difficulty.

Because sewer construction is a major undertaking, it is planned with future needs well in mind, but many of the sewers are now reaching a stage where they are operating at maximum capacity. To reconstruct them will be expensive—recent work to deal with overloading of a sewer in Birmingham cost over £100 a yard. Some local authorities make a charge for receiving industrial water discharge into their sewers; others do not, the cost being spread over the rates. But whether a direct charge is made or not, it is the ratepayers who will have to stand the expense of new drainage works, and this includes the owners of factories using the system. In many parts of the country the position is that new or reconstructed drainage work will soon be needed if the rise in water consumption continues.

Increased water consumption, therefore, poses two separate but closely connected problems: the cost of supplying more water and the cost of getting rid of it when it has been used.

There is no single answer to the problems set by rising water consumption, but there is one step which can be taken immediately, and which can result in several advantages. It is to examine the way in which a factory uses water, to ensure that it is used in the most economical way. This will not only help both the water supply and drainage authorities, but can often result in substantial cost reductions within the factory.

Leaking stop valves or taps are dealt with as routine by a good maintenance department, but water-using processes are not always planned as well as they might be. A simple hose, used intermittently, can waste quite a lot of water if it is left running when it is not actually in use, as it very likely will be, if the periods between use are short and the operator has to walk some distance to turn it off. A self-closing tap on the end of the hose may be all that is necessary to prevent waste. Individual economies may be small, but cumulatively they are often worthwhile.

It is for cooling purposes that the greatest single quantity of water is used in industry, and it is here that the savings due to economy can be particularly worthwhile. Many industrial concerns do, of course, save water by recirculation; power stations, chemical works, oil refineries, and iron and steelworks are perhaps the most obvious examples. In some cases closed circuits are used for operational as well as economic reasons, but in every case it is true to say that the financial advantage is worthwhile.

A recent survey carried out in Birmingham by the Birmingham Junior Chamber of Commerce† covered 64 firms using a total of 5,134 million gallons of mains water in 1958, over 50 per cent of all metered supplies in the City Water Department's area. Of these 64 firms a large proportion re-used water and 39 of them showed a total reduction of 2,205 million gallons by re-use in 1958. The firms in question varied in size and their individual consumption figures were of necessity different. It has been estimated, however, that a saving of over £4,000 per year per firm was the average gain from the re-use of water.

Economies were effected in various ways. Running or pumping the water from one process to another, instead of feeding each process from the mains, is effective where process work does not contaminate the water or heat it too much for immediate re-use. Inter-process filtering and/or cooling is possible by a variety of commercially available plant if necessary. In many chemical and other processing works the "kettle" is a familiar piece of plant, use for evaporation or crystallisation. Usually, the water vapour driven off the material being processed is allowed to escape to atmosphere. Yet if this vapour is condensed, it can provide a useful source of good quality water for use in other parts of the works. Even the water from centrifuges can be, and is, re-used to advantage. These are but a few ways in which economy in the use of water can be practised.

USING AIR

Finally, of course, it is sometimes possible to economise to the extent of not using water at all for certain process cooling work. Process cooling by air first found favour at oil refineries in arid parts of the world where water supplies were inadequate or non-existent, and has spread to many other districts by virtue of its technical advantages. Air cooling is used, for example, in some Continental oil refineries, and at the Whitegate refinery of the Irish Refining Company in Eire; at the latter place sea water is available, but air cooling offers technical advantages which were the deciding factor.

Lack of floor space is sometimes a source of difficulty when recirculation or cooling plant is being considered, but much of this equipment can be installed on a factory roof; in the case of air cooling plant this is probably the best place for it. Financial considerations, too, are important. In the short term view it might appear cheaper to buy all the water needed and run it to waste, but it can often be shown that plant for re-use of water will pay for itself in a reasonably short time.

* Central Advisory Water Committee. Sub-committee on the growing demand for water. First Report 1959. HMSO 1*s.* 3*d.*

† "The Industrial Re-use of Water in the Birmingham Area." Report of a Sub-committee of the Civic Affairs and Manufacturing Committees, Birmingham Junior Chamber of Commerce. 1960.

On the Shelf

By Frank H. Smith

With the arrival in this country of a fat volume entitled *Forty Fourth Annual Report of the National Advisory Committee for Aeronautics* we see the end of an era.

The first annual of this American body was published in 1916 and contained just over 300 pages. Report No. 1 was "Experimental Analysis of Inherent Longitudinal Stability for a Typical Biplane" by a gentleman named Jerome C. Hunsaker, of whom you may have heard. The last volume is of 1,494 pages and finishes with Report 1392, "Boron and Zirconium from Crucible Refractories in a Complex Heat-Resistant Alloy," which is a title of which those 1916 boys would never have thought in connection with aircraft. Our own Aronautical Research Council ante-dated NACA by about seven years and still lives on. Of course NACA also lives, but as the National Aeronautics and Space Administration.

A directory of research organisations might be useful and, judging by their booklet, a worthy entrant would be the central laboratories of the Chloride Electrical Storage Company Limited. The booklet is called "Battery Research and Development" and I suggest you try Fletcher Avenue, Clifton, Swinton, Manchester, or the London office at 50 Grosvenor Gardens, London, SW1.

DSIR *Technical Digests* ("to call attention to useful items in technical literature") numbered 1136 and 1165 are out. They are prepared to send a sample set to anybody likely to be interested and the address is 5-11 Regent Street, London, SW1. Heaven knows how they select what goes into these digests but I can tell you there's quite a range. It's so wide that I just cannot give samples.

Harrap (182 High Holborn, London, WC1) are doing *General Shop for Everyone*, by Dr. L. V. Newkirk, which they describe as the apprentices' vade-mecum. A new edition has also been produced of D. M. Turner's *The Book of Scientific Discovery* at 15*s*. Revision has been made of the text on atomic energy, space, automation and other areas of recent discovery.

The American Society for Testing Materials gets its catalogue of publications up rather nicely. I am particularly fond of their STP series (Special Technical Publications) which are overflowing with the meat (mixed metaphor?) of whichever subject they happen to treat. From 1916 Race Street, Philadelphia 3, Pa.

From the Engineering Publications Office of the Engineering Experiment Station at the University of Illinois, Urbana, Illinois, comes a four page leaflet, the first issue of a news bulletin called *Engineering Outlook*. It is largely chit-chat but entertaining chit-chat with a technical slant.

Aslib are issuing a circular extolling the virtues of their *Commonwealth Index of Unpublished Scientific Translations*. If you have anything at all to do with translation and do not know about this service I earnestly beseech you to ask them for your good and for the good of the community.

The National Joint Committee on Materials Handling (32 Watling Street, London, EC4—CITy 7045) has revised its film list—originally 1958 vintage—and the new version, dealing with about 100 films, may be obtained for a florin and no postage.

With the onset of tests for olde chariots you may like to know of a catalogue from Autobooks, 104 Islingword Road, Brighton. Item 430, for instance, is a reprint of the first issue of *Horseless Age*. It is dated November 1895.

I had occasion to take my drawer right out of my desk the other day. You should have seen the stuff that had collected at the back! Don't worry—you'll get it all, in time. When I've blown the dust away.

Twelve Plastic Polymers

Reinhold Plastics Applications Series:

Polyethylene. By Theodore O. J. Kresser. (40*s*)
Cellulosics. By Walter D. Paist. (46*s*)
Vinyl Resins. By W. Mayo Smith. (46*s*)
Polyurethanes. By Bernard A. Dombrow. (36*s*)
Polyamide Resins. By Donald E. Floyd. (36*s*)
Epoxy Resins. By Irving Skeist. (44*s*)
Gum Plastics. By M. Stafford Thompson. (36*s*)
Fluorocarbons. By Merritt Allen Rudner. (46*s*)
Laminated Plastics. By D. J. Duffin. (46*s*)
Phenolic Resins. By David F. Gould. (46*s*)
Acrylic Resins. By M. B. Horn. (36*s*)
Silicones. By Robert N. Meals and Frederick M. Lewis. (48*s*)

Reinhold Publishing Corporation, New York; Chapman and Hall, London.

Plastic materials have established their importance by invading almost every part of modern life. It is a long step from early plastics (known as "synthetic materials," with the implication that they were inferior to standard products) to the wide range of polymers marketed today. From these substances, it is possible to choose one with properties to fit a given application. More and more, plastics are replacing wood, metal and ceramics in many articles; the total home consumption for 1959 was 395,000 tons.

Plastics are organic substances of large molecular weight, which are used as solids and pass through a plastic or mouldable stage in their manufacture. The large molecules may be prepared from natural products, themselves containing large units, for example cellulose, or can be built up from small units. The basic molecule in the plastic is known as a monomer which can be built up into a complete polymer. The types of units and methods of synthesis decide the properties of the final material. Thermoplastic materials resoften on heating and can be re-used, while thermosetting materials char or dissociate on further heating.

Over the last two years, the Reinhold Publishing Corporation have issued a series of books—*Plastics Application Series*—covering the main types of plastics.

The books are mainly devised to give practical information on the manufacture and application of the polymers; the chemistry and future prospects of the materials are also discussed. Although it is possible to criticise the general layout, indexing and chemical information in some of the volumes, the series form a valuable guide to engineers in the plastics industry and to those thinking of using plastics for particular applications. Design of parts and special properties are, in general, well covered.

If we consider the properties and applications of the various polymers, the extent of their usage will become evident.

Polyethylene

This plastic is a waxy polymer derived from ethylene and was first developed as an ultra-high-frequency insulating material for radar applications. It is now extremely well known in the domestic field and is used in basins, bins and buckets. About a third of the total output is used on moulded articles.

Polyethylene is a good insulator, is corrosion resistant and is not wetted. The initial disadvantage of limited usage at high temperature (maximum about 70° C) has been overcome by the introduction of high-density polymers capable of functioning at over 100° C.

Moulded articles are used as unbreakable containers for many liquids and in household ware. Extruded pipework is found in the chemical industry and is replacing conventional water piping. Polyethylene film has a variety of uses in packaging and as water-proof sheeting. Monofilaments are woven into cloth and ropes which are water repellent and light enough to float. Other uses include electrical applications and coatings on paper.

Recently, other higher olefine polymers have been prepared (for example, polypropylene). These have higher melting points and increased rigidity.

Cellulosics

The cellulose based plastics are derived from cotton or wood fibres. Celluloid or cellulose nitrate was one of the earliest of the polymers. Its main disadvantage was extreme flammability and cellulose acetate was developed to overcome this.

Cellulose polymers are readily extruded and are available in a variety of colours, including mottled effects; products include radio cabinets, pens, pumps, spectacle frames and telephones. The film is extensively used in packaging (Cellophane), photographic film and magnetic tapes. Woven filaments are found in a variety of fabrics of the rayon type, which are employed as tyre reinforcement among other things. A recent variant known as Tricel has a more woollen texture. Cellulose compounds are also used as adhesives and in emulsion paints.

Vinyl Resins

For many years the vinyl resins have been the most widely used of all the plastic materials. The best known member is polyvinyl chloride (pvc). Combined with plasticisers it forms a rubber-like material, which has good electrical insulation properties and is resistant to corrosive fluids, oils and solvents.

A major advantage over natural rubber is its low flammability. Pvc elastomers are used extensively as insulation on electrical wiring, as flexible tubing, as waterproof sheeting and as floor tiles. Coatings are applied to metal frames as anti-corrosion coverings (for example, acid baths) and on a fabric base, the finished material has replaced leather for many applications.

Recently, the unplasticised or rigid pvc has grown in importance. Piping, vessels and other equipment of this material have been fabricated for the handling of corrosive liquors and fumes.

Starting with vinyl acetate the polyvinyl acetate resins can be produced. These are being used in adhesive and coating applications.

Polyurethanes

Polyurethanes are formed from the reaction of di-isocyanates and compounds containing hydroxyl groups. By altering the nature and amount of the materials the product can be varied from a rigid to a flexible plastic. The di-isocyanates will also react with water to form carbon dioxide and urea derivatives and this liberation of gas is used in the formation of foamed plastics.

The material is resistant to solvents and detergents and can be used to a temperature of 120° C. Flexible foams are effective in packaging to prevent impact damage and are replacing standard spring cushions in furniture. Rigid foams can be formed *in situ* and have useful electrical and thermal insulation properties, while possessing good structural strength and lightness (densities of 2 lb per cu. ft can be prepared).

The polyurethanes are being used as elastomers with outstanding chemical and abrasion resistance. They also appear to be less affected by radiation damage than rubbers. Urethane adhesives give very good bond strength on a variety of materials, including wood, vinyls, glass and ceramics.

Polyamides

In 1928 du Pont's W.H. Carothers set out to devise a plastic material capable of being formed into a filament. The "nylons" so produced have given rise to a range of polyamide plastics. These fall into the following four groups depending upon the starting material:

(1) condensation of diamines with dibasic acids: nylon 6,6 or nylon 6,10 (where the

numbers relate to the carbon atoms in the particular group);

(2) polymerisation of lactams—nylon 6;

(3) self-condensation of amino-acids—nylon 11;

(4) resins based on polymerised vegetable oils, acids—Versamids, which are used in adhesives, coatings and combined with epoxy resins to form thermosetting materials.

The nylons can be used to temperatures of 120 to 130° C, have good resistance to solvents and chemicals other than strong acids, have high tensile strength and good abrasion resistance. The use of nylon filaments in hose, fabrics and ropes is now well established. Moulded articles are increasing in importance—gears, cams, bolts, bushes and bearings are being manufactured. Nylons tend to absorb moisture with some slight swelling. The nylon 11 material is least affected and the materials can be stabilised by boiling in water until approximately 3 per cent has been absorbed.

Pipework is being made in nylon 6, and nylon 11 can be extruded to produce film. Coatings for anti-corrosion and anti-abrasion purposes can be applied by spraying or a fluidising method.

Epoxy Resins

Most of the epoxy resins are derived from epichlorhydrin and diphenols and owe their behaviour to the epoxy group present in the epichlorhydrin. This grouping is a three-membered carbon-oxygen-carbon ring, which readily reacts with compounds containing active hydrogen, for example, amines, acids, phenols, alcohols, and so on.

The resins are converted into thermosetting materials by the addition of curing agents. Reaction can often take place at room temperature (cold-setting), but maximum properties are produced in the shortest time by curing at elevated temperatures up to 200° C. The period over which the resin can be used after addition of the hardener is known as the pot life.

The epoxy resins are resistant to acids and alkalies, cure without evolution of volatiles and with minimum shrinkage, have remarkable adhesion and good electrical properties. Epoxy-based coatings are durable, corrosion resistant and waterproof. In the adhesion field the epoxy resins give bonds with very high strength even with glass or ceramics. Metal to metal bonding can be obtained without rivets or screws. Filled material has been used as plastic solder or can be cast into metal forming moulds. Electrical components are being protected from corrosion and breakage by use of epoxy encapsulating or potting compounds. The good adhesion to glass and low shrinage on curing makes the material a satisfactory resin for glass reinforced plastics.

Some care is necessary in the handling of the epoxies as the amine hardeners are somewhat toxic and can lead to dermatitis.

Gum Plastics

The main gum plastics are impact-polystyrene, ABS polymers (acrylonitrile-butadiene-styrene) and impact-rigid pvc. The base thermoplastic resins are modified by the incorporation of an elastomeric or rubber-like polymer. By selection of the elastomer, reaction of the resin and subsequent processing, a material is obtained with a high level of mechanical strength and toughness.

High impact polystyrene is reasonably resistant to chemical and solvent attack; it has good mechanical and electrical properties and dimensional stability. The material can be produced in pastel shades with a high gloss finish, which is chip and scratch proof. Extruded or calendared sheet can be made into large mouldings by heating and vacuum forming, for example, complete refrigerator liners have been produced. Smaller mouldings cover the range of radio cabinets, fancy goods, cupboard drawers and similar goods.

ABS and impact pvc are becoming increasingly important in the plastic-pipe field. Apart from the high strength and increased rigidity, these materials are little affected by chemicals and solvents; weather and ageing resistance are good, particularly when compounded with carbon black. Gears and other mechanical parts are also being produced in ABS polymer.

Fluorocarbons

The important polymers in the group of carbon-halogen materials known as fluorocarbons are polytetrafluoroethylene (ptfe) and polychlorotrifluoroethylene (pctfe). These resins are the most resistant of the plastics and able to work over a large temperature range (−200° to + 200° C). They are very resistant to chemicals and solvents, have good electrical properties, are anti-adhesive and have a low coefficient of friction.

Ptfe is expensive and more difficult to process than normal thermoplastics. The resin has to be cold formed by pressing or extrusion and then heated to 360° C, at which temperature it can be consolidated. Pctfe has the advantage of a definite melting point and hence can be processed by conventional techniques. It is, however, less resistant than ptfe.

The fluorocarbons are specialist plastics which are used when outstanding corrosion resistance is required, in high-frequency electrical applications and as anti-stick coatings, for example, in pump parts, piping, bearings, packaging, machinery and food equipment.

Laminated Plastics

Laminated plastics are layers of resin-impregnated or resin-coated filler, which are bonded together, usually by heat and pressure, to form a strong coherent mass. The resins are normally thermosetting plastics, for example, phenolic, polyester, epoxy and the fillers may be paper, cotton, glass fibre—or asbestos. Depending upon the pressure required the laminates can be divided into high-pressure laminates (over 1,000 lb per sq. in) or low-pressure laminates which now include the so-called reinforced plastics.

High-pressure laminates are made by coating or impregnating the selected base material with the resin solution and then drying under controlled conditions. The initial rolls of material are cut into sheets for making up into layers of various thicknesses. Any shaping is then carried out, using moulds or mandrels, and the whole material is converted into a homogeneous mass by the application of pressure (1,000 to 1,200 lb per sq. in) at temperatures of 150 to 180° C; sheets, rods and tubes and moulded shapes can be made.

The main resin type in high-pressure laminates is phenolic but melamine resins are also used, particularly for decorative laminates. By selection of the resin and base material a range of properties can be obtained. In general, the laminates have good corrosion resistance, good electrical properties, remarkable strength-to-weight ratio and good wear resistance. The applications range from decorative laminates (wall panels, table tops, etc.) to gears, bushes, brake linings, chemical equipment, electrical panels and formers.

The reinforced or low-pressure laminates are becoming increasingly important and the use of glass-polyester articles is growing rapidly. These laminates may be press-moulded using preform or premix material and heating to about 120° C under pressure of 100 to 400 lb per sq. in. Alternative methods are bag moulding where a clamped elastomer bag compresses the layers into the mould—vacuum or pressure can be used—and then curing at temperature. Contact moulding is used for boats and large shapes. The materials are built around a mould, which can be made of plastic, wood, cement, and comparable materials, and cured without application of pressure. Recently, it has become possible to spray the mixture of glass and resin into the mould instead of the former method of building up by hand.

With the ease of shaping, resistance to corrosion, incorporation of permanent colours, high impact strength and low weight, glass-polyester materials are being used in a variety of applications—car bodies, boats, swimming baths, etc. Corrosion resistant piping that is made of glass-resin materials is able to stand higher pressures and temperatures than other forms of plastic piping.

Phenolic Resins

The phenolic resins were the first of the thermosetting plastics, having been produced commercially for 50 years and are still the main resin in this group (75,000 tons out of a total of 195,000 tons in 1959).

Phenols, derived from coal-tar sources or produced synthetically, are reacted with an aldehyde, using an acid or alkaline catalyst. The resins are mixed with various fillers—wood, flour, cotton, asbestos, graphite, mica, etc.—and a wide range of properties is obtained. Generally, the materials are strong, have good resistance to chemicals and are good insulators. Additional heat resistance, frictional properties, wear resistance, may be imparted by careful selection of resin and filler.

Phenolic mouldings are used in the form of control knobs, switches, cabinets, terminal blocks and heat-resistant handles. The importance of phenolic resins in high-pressure laminates has been discussed previously. Phenolic adhesives have high strength and are resistant to heat, moisture, chemicals and fungi. They can be made less brittle by alloying with elastomers and give a good bond with metal, wood and many plastics. The adhesives are used for plywoods, foundry moulds, bonding of abrasives and so on. Phenolic resins, either alone or in combination with other resins, give satisfactory coating compounds. Stoved films, particularly, give a hard durable coating resistant to heat, solvents and chemicals.

Acrylics

The acrylic polymers are esters, nitriles and amides of unsaturated organic acids based on acrylic or methacrylic acid. They are thermoplastic materials, which exhibit crystal clarity and high impact strength; they are readily formed and have good resistance to weathering, sunlight and chemicals.

Methyl methacrylate polymer (Perspex) was first used for aircraft-cockpit domes, since it was lighter and stronger than glass, could be shaped and had excellent optical properties. This type of application has been extended to inspection windows, instrument covers, machine guards and specimen mounts. Corrugated sheets of the plastic are used as skylights in industrial buildings.

The material has the ability of " piping " light and this property has been used in medical examination instruments, in advertisement signs and in decorative panels. Acrylic mouldings include coloured telephone handsets and lampshades. Combined with elastomers, the acrylics give superior durability and toughness (ABS polymers). Fibres of acrylic materials are being used in clothing (Orlon, Acrilan) alone or as blends; acrylics are also employed as sizing agents for cotton and rayon, to give improved strength and better wear resistance.

Silicones

The silicones constitute a whole range of polymers with some of the carbon atoms replaced by silicon; silicon atoms, to which organic groups are attached, alternate with oxygen atoms. We are, therefore, considering a range of varying materials—fluids, greases, elastomers and thermosetting resins. In general, the silicones are resistant to chemicals, are water-repellant and can be used over a wide temperature range. They are expensive materials and consequently are used only for special purposes.

Silicone oils and greases have high thermal stability, a low viscosity temperature coefficient and low volatility. They allow lubrication over

Continued on next page

a temperature range (−70° to + 250°C), have good dielectric properties and can be used for high vacuum systems.

Various silicone fluids in aqueous and solvent media are used as release agents in moulds, as anti-foaming agents and for water-repellant treatment on brickwork.

The silicone rubbers retain their properties over a large temperature range, have fair resistance to chemicals and good insulation properties. Rubber mouldings (as used for gaskets and O-rings), wire covering and coatings are employed, particularly at the higher temperatures (up to 250° C).

Thermosetting silicone resins using inorganic or glass fibre fillers are made into mouldings and laminates. These retain excellent physical and electrical properties in continuous service at high temperatures; they are widely used in high-speed aircraft and rockets.

This review has briefly covered the properties and applications of some of the main plastics. The increase in experimental work on structure and synthesis is helping to produce new polymers with tailor-made properties and the increased usage of plastics is likely to continue.

E. FRANKS

Catalysis Among the Pigeons

The Catalyst. By G. O. JONES. *Faber and Faber.* (13*s* 6*d*)

A first attempt to analyse human relationships and emotions in the form of a novel, this book has been written by a senior member of the physics department of an English university.

The author places his characters against a background of chemical industry but the novel is in no sense a description of industry. The central character, somewhat colourlessly named Smith, is introduced to the reader as a callow university product, inordinately proud of his bachelor's degree but with mediocre academic and social qualifications. Smith, we discover, has managed to place himself prematurely on the brink of matrimony. The serenity of his circumstances are in the process of being disturbed by his future sister-in-law, already adequately married but determined to force her attentions upon Smith.

The central character is one of several university graduates who are employed by this branch of industry. The working environment which this firm has created is a thoroughly unsatisfactory one, derived from irrational mismanagement, business intrigue and centripetal interest in the company's social club. All of these act speedily on the raw young chemist. He is obsessed with an urgent desire for promotion, though we are neither shown how he has earned it nor do we expect him to deserve it.

An assignment at a distant factory owned by the firm, in which production has ceased and which is on a care-and-maintenance basis, gives Smith his first taste of management. Unfortunately for him there is nothing there for him to manage or to mismanage; as we might expect from the rather nebulous character which the author has sketched, his inaction leads him to divide his time between an affair with his typist and the marking of school examination papers. When his dallyings have spent themselves in a downtown slum, he belatedly decides that a return to headquarters would be appropriate and convinces his chief of that. He is reunited with his wife and at last is given work in which his moderate scientific talents are more completely employed.

His wife's pregnancy is allowed to provide a simple solution to Smith's personal problems and we leave him poised on the threshold of proud parenthood, a wiser but still a sad and uncertain young man.

The novel is about people and is told simply and directly. Much of it is factually correct. But it fails to deal adequately with the people who form its subject matter and what is expressed is only a rather disappointing part of the story as it might have been. The inadequate treatment of the depths of human nature and a lack of warmth of feeling in the writing of the book have resulted in the production of a sour and jaundiced case-history of a dozen or so psychopaths. None of the characters, so far as we are permitted to view them, are either normal or happy persons. The author's analytical training has been allowed to play havoc with this first attempt at unscientific writing.

The facts which *The Catalyst* present to the reader about the function of scientifically trained staff in industry—be they chemists, physicists or engineers, graduates or non-graduates—are a travesty of reality and verge in places on the farcical. This is difficult to understand since in his specialised career the author must have had many opportunities for fringe contacts with well organised industry. One gains the impression from his book that industrial work would be anathema to him, that he feels that university graduates have no logical place within the framework of industry and that once within it, their mental and moral well-being must inevitably disintegrate. Perhaps this is ill-disguised academic snobbery and a wider and a more tolerant knowledge of industrial conditions would surely have shown such misconceptions to be both incorrect and dangerous. It may be that cynicism has blinded the author and prevented his proper appreciation of the true facts. On the other hand, however, it may merely be an instance of the rabid physicist, tongue firmly in cheek, taking it out of his chemical colleagues.

E. M. PATTERSON

New Books

Die-Sinking and Engraving Machines. By H. C. TOWN. Machinery's Yellow Back Series No. 45. *Machinery Publishing Co. Ltd.* (5*s*)

The control of die-sinking and engraving machines by electrical, electronic and hydraulic systems, and a special chapter on pantograph machines.

Turbulence. By J. O. HINZE. *McGraw-Hill, New York and London.* (116*s* 6*d*)

A survey of current theories of turbulent fluid flow and the principles of methods and techniques in the measurement of turbulent flows. A fair knowledge of physics and mathematics is a prerequisite, although the reader need not be an expert in fluid flow.

Nuclear Radiation Engineering: An Introduction. By F. W. HUTCHINSON. *The Ronald Press Company, 15 East 26th Street, New York 10, N.Y., USA.* ($6·00)

Designed for administrators and engineers in fields marginal to nuclear engineering, the book is intended to serve as the equivalent of a language primer—to help remove the semantic barrier between the nuclear scientist or engineer and the executive.

An Introduction to the Dynamics of Framed Structures. By GROVER L. ROGERS. *Wiley, New York; Chapman and Hall, London.* (82*s*)

An exposition of the theory of structural dynamics as it pertains to the special problems of beams and rigid frames, particularly intended for the designers of bridges and buildings.

The A.B.C. of "Electronic Brains." By LEON BAGRIT. *British Broadcasting Corporation.* (1*s* 6*d*)

A series of six talks originally broadcast in the external services of the BBC, now reprinted with explanatory photographs and diagrams.

Data Sheets on Moulding Sands. *The British Steel Castings Research Association, East Bank Road, Sheffield 2.* (30*s*)

Sources, chemical analysis, mechanical analysis, grain shape, refractoriness, and cumulative grading curves are given for 45 British and Continental sands suitable for foundry moulding purposes.

The British Journal Photographic Almanac, 1960. Edited by ARTHUR J. DALLADAY. 101st edition. *Henry Greenwood and Co. Ltd., 24 Wellington Street, London, WC2.* (8*s*)

Special articles in this year's BJ Almanac include "World Trends in Colour Film" and "The Aviation World," while among regular features are the editorial review of new apparatus and materials, running to over a hundred pages, and an up-to-date directory of repairers.

Das Waagerecht-Bohr- und Fräswerk und seine Anwendung. By HEINRICH SCHALLBROCH. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (26·70 *DM*)

A practical handbook on horizontal borers and millers, produced by Dr. Schallbroch on behalf of Scharmann and Company and lavishly illustrated with details from current machines.

Refined Iterative Methods for Computation of the Solution and the Eigenvalues of Self-Adjoint Boundary Value Problems. By M. ENGELI, TH. GINSBURG, H. RUTISHAUSER and E. STIEFEL. *Birkhäuser Verlag, Basel.* (17 *SFrs*)

The results of the work of a team of four scientists at the Institut für angewandte Mathematik, Zürich, on relaxation methods for solving elliptic partial differential equations. The help of the IBM 704 in Paris is acknowledged.

Random Vibration. Edited by STEPHEN H. CRANDALL. *Published jointly by the Technology Press of The Massachusetts Institute of Technology and John Wiley and Sons, New York; Chapman and Hall, London.* (68*s*)

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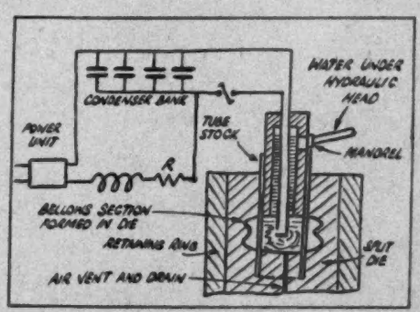

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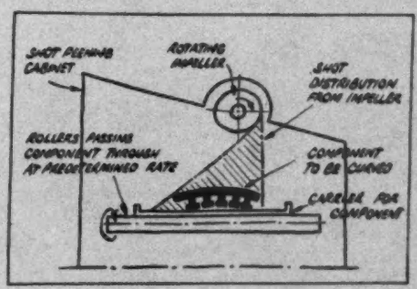

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The A.B.C. of "Electronic Brains." By LEON BAGRIT. *British Broadcasting Corporation.* (1*s* 6*d*)

A series of six talks originally broadcast in the external services of the BBC, now reprinted with explanatory photographs and diagrams.

Data Sheets on Moulding Sands. *The British Steel Castings Research Association, East Bank Road, Sheffield 2.* (30*s*)

Sources, chemical analysis, mechanical analysis, grain shape, refractoriness, and cumulative grading curves are given for 45 British and Continental sands suitable for foundry moulding purposes.

The British Journal Photographic Almanac, 1960. Edited by ARTHUR J. DALLADAY. 101st edition. *Henry Greenwood and Co. Ltd., 24 Wellington Street, London, WC2.* (8*s*)

Special articles in this year's BJ Almanac include "World Trends in Colour Film" and "The Aviation World," while among regular features are the editorial review of new apparatus and materials, running to over a hundred pages, and an up-to-date directory of repairers.

Das Waagerecht-Bohr- und Fräswerk und seine Anwendung. By HEINRICH SCHALLBROCH. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (26·70 *DM*)

A practical handbook on horizontal borers and millers, produced by Dr. Schallbroch on behalf of Scharmann and Company and lavishly illustrated with details from current machines.

Refined Iterative Methods for Computation of the Solution and the Eigenvalues of Self-Adjoint Boundary Value Problems. By M. ENGELI, TH. GINSBURG, H. RUTISHAUSER and E. STIEFEL. *Birkhäuser Verlag, Basel.* (17 *SFrs*)

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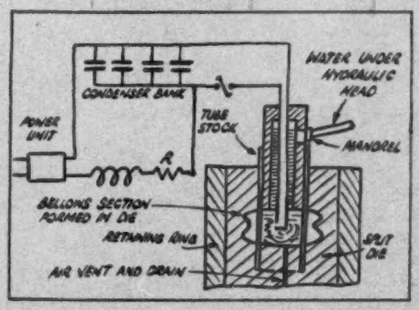

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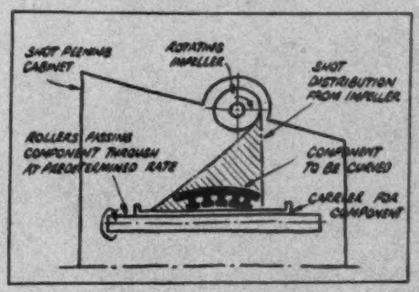

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Designed for administrators and engineers in fields marginal to nuclear engineering, the book is intended to serve as the equivalent of a language primer—to help remove the semantic barrier between the nuclear scientist or engineer and the executive.

An Introduction to the Dynamics of Framed Structures. By GROVER L. ROGERS. *Wiley, New York; Chapman and Hall, London.* (82*s*)

An exposition of the theory of structural dynamics as it pertains to the special problems of beams and rigid frames, particularly intended for the designers of bridges and buildings.

The A.B.C. of "Electronic Brains." By LEON BAGRIT. *British Broadcasting Corporation.* (1*s* 6*d*)

A series of six talks originally broadcast in the external services of the BBC, now reprinted with explanatory photographs and diagrams.

Data Sheets on Moulding Sands. *The British Steel Castings Research Association, East Bank Road, Sheffield 2.* (30*s*)

Sources, chemical analysis, mechanical analysis, grain shape, refractoriness, and cumulative grading curves are given for 45 British and Continental sands suitable for foundry moulding purposes.

The British Journal Photographic Almanac, 1960. Edited by ARTHUR J. DALLADAY. 101st edition. *Henry Greenwood and Co. Ltd., 24 Wellington Street, London, WC2.* (8*s*)

Special articles in this year's BJ Almanac include "World Trends in Colour Film" and "The Aviation World," while among regular features are the editorial review of new apparatus and materials, running to over a hundred pages, and an up-to-date directory of repairers.

Das Waagerecht-Bohr- und Fräswerk und seine Anwendung. By HEINRICH SCHALLBROCH. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (26·70 *DM*)

A practical handbook on horizontal borers and millers, produced by Dr. Schallbroch on behalf of Scharmann and Company and lavishly illustrated with details from current machines.

Refined Iterative Methods for Computation of the Solution and the Eigenvalues of Self-Adjoint Boundary Value Problems. By M. ENGELI, TH. GINSBURG, H. RUTISHAUSER and E. STIEFEL. *Birkhäuser Verlag, Basel.* (17 *SFrs*)

The results of the work of a team of four scientists at the Institut für angewandte Mathematik, Zürich, on relaxation methods for solving elliptic partial differential equations. The help of the IBM 704 in Paris is acknowledged.

Random Vibration. Edited by STEPHEN H. CRANDALL. *Published jointly by the Technology Press of The Massachusetts Institute of Technology and John Wiley and Sons, New York; Chapman and Hall, London.* (68*s*)

The development of high power rocket and jet engines has introduced a new aspect to the problem of mechanical vibration. The present book is based on papers given at a special MIT programme held in 1958.

The Reviewers

Mr. E. Franks, B.Sc., A.M.I.Chem.E., is project leader in the research department of the Morgan Crucible Company Limited, where he is engaged in development work on plastics, carbon and silicon carbide. He has also completed four years work on fibres, elastomers and ptfe with Crane Packing Limited.

Dr. E. M. Patterson has been employed in chemical industry and on the lecturing staff of St. Andrews University for eleven and seven years respectively. He holds degrees of B.Sc., M.Sc. and D.Sc. in chemistry and geology, and is a fellow of the Royal Society of Edinburgh, a member of the Royal Irish Academy, and a fellow of the Royal Institute of Chemistry.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Locomotives

Diesel Hydraulic Locomotives. BEYER PEACOCK (HYMEK) LTD., Locomotive House, Buckingham Gate, London, SW1. Hymek diesel hydraulic locomotives as ordered for the British Transport Commission. Bristol Siddeley-Maybach engines and Stone-Maybach transmission. Leaflet gives details.

Diesel Shunters. JOHN FOWLER AND CO. (LEEDS) LTD., Hunslet, Leeds 10. Diesel shunting locomotives with hydraulic or mechanical transmission. Range of standard sizes with notes on operating costs. Booklet.

Electric Locomotives. ENGLISH ELECTRIC LTD., Marconi House, Aldwych, London, WC2. Class 5E electric locomotives for use in South Africa; 2,000 h.p., 3,000 volt d.c. Particulars and performances given in publication TD/151.

Advanced Methods for Forming Metals

The metal deformation processes used in production now and those which will come into use in the near future are reviewed against the background of metallurgical change which accompanies the deformation.

By W. S. Hollis, Ph.D.

Assistant Director, Aircraft Production Development, Ministry of Aviation

THE demand for improved strength to weight ratios in constructional metals has brought about the use of more complex alloys which, by their improved resistance to deformation, are more difficult to hot work. The difficulty is not overcome by adopting higher forging temperatures, since surface contamination and general grain enlargement can follow. Burning of the metal occurs at sites where incipient melting produces damage to grain boundaries which cannot be rectified by further heat treatment. Again high strength materials are naturally more difficult to machine and lean allowances must desirably be made to reduce machining costs. Any fresh development in the process of deforming tough alloys must, therefore, relate its primary object to the production of metallurgically sound close dimensional limit components, while the economics of applying these developments to more easily worked materials is not entirely missed in this competitive and cost conscious era.

Most of the sequences of the heating cycle required for deforming can be related to changes which are required in the crystal structure of the metal—the purpose being to enable deformation to proceed at relatively low stresses. Without heating, it is not practicable to apply the large strains encountered in the deforming. Excellent instances of this are found with beryllium and certain of the titanium alloys. Lattice stresses also produce a resistance to forming by creating an unbalance in the atomic arrangement. The process of precipitation is closely allied and the effects must be removed by holding at an annealing temperature. The criteria hold in a general manner whether the manipulation process to be carried out is forging, rolling or extrusion and extends to those cold working operations encountered in workshop fabrication.

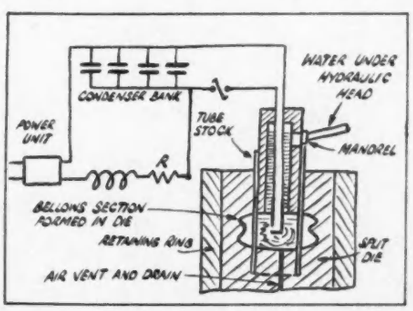

Fig. 1 High energy forming by electrical discharge.

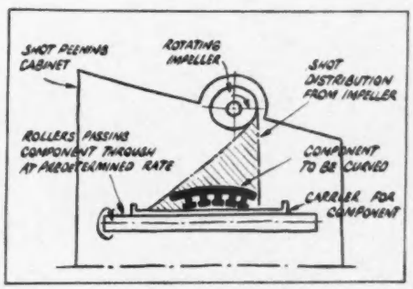

Fig. 2 Shot peening.

In the process of cold forming, the rate of applied straining is important. Exceptionally low straining rates give randomly oriented crystal structures an opportunity to present, by twinning, sufficient planes to permit the required deformation to occur. This is the principle of deformation generally applied in die hobbing. Conversely, at extremely high strain rates there is sufficient heat energy in the area of straining to dominate the effect of work hardening. Strain rates of this order are associated with impact extrustion and explosive forming.

All deformation requires a level of energy to be reached which allows the required movement at the deformation sites. Heating will raise the level of energy in the area of deformation so that the subsequent deforming is easy. Without this, the rate of deformation has to produce an equivalent total heat energy at the same deformation site and this must be present until straining has ceased. If the rate of strain is sufficiently high, so that no significant quantity of heat is conducted away from the region of deformation until straining has ceased, adiabatic strain rates are said to apply. The rate and magnitude of strain imparted during certain modes of deformation, as, for example, found in upsetting under a pneumatic hammer, can effect an increase in the temperature of the stock above that at which it was held in the furnace.

FORGING

The demand for high quality forgings has brought about considerable care in upsetting the ingot. Many considerations are involved. The as-cast crystal structure changes from equiaxed at the centre to columnar at the surface and needs rectification; segregations and porosities have to be dispersed. Metallic carbides and inter-metallic compounds, upon which many of the creep resisting alloys depend for high temperature properties, migrate to the grain boundaries in the cast stage and have to be dispersed in the breaking down operation. The methods employed require light plastic deformation in the initial stages of breaking down; the extent of deformation increasing as the inter-granular material is dispersed. The subsequent solution heat treatment and precipitation characteristics depend to a great extent on the breakdown and upsetting processes applied.

Heating is by electrical resistance or induction methods on account of the greater control exercised. Atmospheric control plays an important part in the heating of many metals, particularly the high nickel base alloys where sulphur is an obvious contaminant. Titanium requires an atmosphere free of the intersitital elements, carbon, oxygen, nitrogen and hydrogen, although a weak oxidising atmosphere is permissible providing mechanical descaling and pickling is carried out. Beryllium is extremely sensitive to oxygen and like tungsten and molybdenum, requires a reducing atmosphere.

Tungsten carbide and titanium carbide are used in a limited field as engineering materials. In the green state, the metal is nowadays improved by compacting under high hydrostatic loads, since this is found to reduce susceptibility to shock. Gas turbine blades, tool shanks and small diameter mill rolls are new applications to which the materials have been applied.

The excellent homogeneity produced by high hydrostatic pressures in cold forming of components is receiving attention, resultant mainly from reports emanating from the USSR. Typically, brittle metals such as zinc have been shown to extrude satisfactorily by the limited investigations carried out in this country.

The working of refractory metals, carbides and the otherwise brittle materials has, as an ultimate aim, the application of chipless production. All are difficult to machine and some present industrial hazards. The plant and equipment for manipulation will vary widely but the general principles are becoming known and the rate of development will depend entirely upon the demands of military strategy or economic desirability.

EXPLOSIVE FORMING

Explosive forming is essentially the application of a hydrostatic loading which causes the metal to flow at high deformation rates. However, the mode of loading can be varied to produce substantially linear stress conditions such as would be applied in drawing or shearing operations; pressures exerted at right angles to the principal stress ensuring close adherence to the walls of the constraining periphery or cylinder.

Generally the process can be likened to hydroforming excepting that the rates of strain applied to the metal are many orders higher. Directional effect is obtained by shaping of the charge, whereas the applied strain rates are determined by the weight and nature of the explosive employed. Tubular components are formed under conditions of tensile stress and are produced in consequence with small strains and low strain rates compared to sheet materials. Where sheet stock is formed into cavity type dies, vacuum exhaustion of the under surface is desirable; even necessary for thin materials, to prevent entrapped air pockets causing inaccurate forming, localised doming and possibly bursting.

Extensive use of single piece dies is made. For small lots, these are of a rudimentary construction, backed with a heavy mass of shock sustaining material such as kirksite, and retained in a heavy sectioned support ring. The explosive force is contained in a tubular construction, reinforced with a concrete support and sunk in the ground. Depending on the nature of the component to be made, air or water is used as the transmitting fluid. Explosives are selected according to the nature of the work. RDX and PETM give better detonation control and are employed for heavier materials. Charge sizes vary from 10 to 1,000 grammes, the smaller charges being prepared from Cordtex.

The absence of springback reported is due to two factors—uniformity of the applied strains and the adiabatic character of the rate of their application. Fracture incipiency is avoided by the nature of the applied loading conditions; hydrostatic compressive stresses prevent tension conditions leading to necking while the adiabatic

New Directions in Metalworking Practice

This is the third of four special features appearing in successive issues. They highlight the growing points of metalworking practice.

conditions of the applied strain rates assist by avoiding localised high strain values.

Experiments have also been conducted by discharging a condenser bank through electrodes immersed in water. The electrodes are positioned to enable discharge to occur adjacent to the area required to be deformed. The chief application appears to be directed towards thin walled components. High voltages and capacities are required. (See Fig. 1.)

The system is coupled to a mains supply, step up transformer, impedance and resistance which charges the condenser bank. Discharge is effected through sphere type contactors to the electrodes.

Many adaptations of the basic principles appear possible which will enable recharging and the delivery of multiple shock waves to the workpiece. In this manner, high energy forming could become a tool which would enable the progress of the work to be inspected without removal from the die.

HYDRO FORMING

An elastic member such as pvc or rubber can be made to exert hydrostatic pressure when compressed in a containing member. Variations of this system have been employed to produce

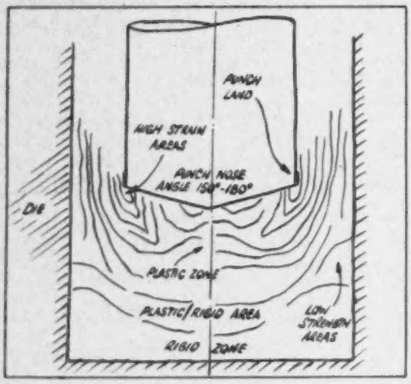

Fig. 3 Hypothetical concept of the slip lines during impact.

components over male type dies and excellent examples of the work undertaken show application to the formation of re-entrant angles and bulges otherwise denied to drawing techniques.

COLD FORMING OF SHEET

The cold forming of sheet covers bending, stretch forming, section rolling, shot peening and pressing. Typical equipment used in the forming of light alloy and steel can also be employed for working titanium alloys, although it is frequently necessary to heat titanium before deforming on account of pronounced cracking encountered at the bend radii due to the large strains which occur at the surface of the material when forming.

Stretch forming is a well established process in the aircraft industry. Stretch-wrap forming is nowadays employed, whereby the panel is tensioned and the form block intruded into the plane surface by a wrapping movement which draws the sheet to the required shape. The principal equipment used is of American origin, there being extensive use of this method of forming in the USA although the principles of stretch forming were developed in the United Kingdom. In the case of the forming of complex components, the retaining jaws are made in elemental sections which can be articulated to conform to the desired contour at the extremities of the die. This avoids wrinkling of the material and obviously prevents metal wastage.

In stretching material of irregular section such as occurs with components which have been machined in the flat prior to forming, it is obvious that strain is the only criteria by which stress can be measured. Provision is made therefore in some designs to limit the permissible movement according to the strain and in some cases to stretch the material in increments where the variation of section demands this.

The curvature produced by shot peening is dependent on an indentation process which extends the surface of the sheet worked upon. (See Fig. 2.) The finer the dispersion, the more refined is the method of control so that it is customary to find shot not greater than $\frac{1}{64}$ in diameter being used. As impacting slivers can penetrate and remain in the surface, care is exercised in the selection of the shot mass to avoid wide differences of electro-potential. Refractory materials and glasses are becoming more extensively used.

The curvature obtained for a given rate of delivery and velocity of shot is fairly constant, so that curvature can be varied either by varying the rate of shot delivered or the traverse rate of the work piece through the shot cabinet. Over curvature can be corrected by working on the opposite face.

IMPACT EXTRUSION

The factors which determine the suitability of a press for cold extrusion are power, rigidity, good alignment of slideways and an adequate bearing against side thrust deflections. The bed of the press needs supporting to resist deflection forces which may impair the alignment during stroking. High speed long-stroking presses usually meet the requirements although some short stroking presses have been designed specifically for the work. Capacity varies between 200 to 2,000 tons according to the component and the material to be worked. Maximum specific pressures vary between five and nine times the yield stress, dependent on the reduction of area affected. Length to diameter ratio has little significant effect for values of one and above.

The cheese or slug is selected from low carbon or alloy steels characteristically leaner than would otherwise be used on account of the improved mechanical properties imparted during cold working. A phosphate treatment preceded by a pickle and a rinse, prepares the surface. Lacquer, waxes, metallic soaps and active compound lubricants are employed according to the techniques developed. Metallic soaps have been found beneficial. The higher strain values and in consequence the greatest increase in hardness are located in the internal corners at the base of the components. Fig. 3 gives a hypothetical concept of the slip lines.

To ensure proper support for the tool, a dimple or central location is preferably formed in the slug; a tool with a suitably formed nose will also improve the slip line mechanism. Misalignment can easily bring about the fracture of the tool so, where practicable, die assembly arrangements should include guide stubs to improve alignment. High chrome—high carbon steels are employed for the punch and dies; the latter being constrained in a shrink fit ring in the manner adopted for carbide die inserts to offset tension stresses. Hardness values for the die and punch are of the order of 600 Brinell (700 DPN), the lower hardness values introduce plastic deformation of a creep character while higher values produce brittle failures in the punch.

Although the process has obvious advantages in the forming of specimens which are produced by combinations of forward and backward extrusions, radial compressive forces accompanying the extrusion can be utilised to shape gear teeth, splines and similar objects which will benefit from the direction of grain flow and surface texture imparted.

Uniformity of the product, high output and avoidance of machining will recommend this process of forming to the automobile industry.

FLOW TURNING

Flow turning is used for the production of conical and cylindrical components from sheet or pre-formed blanks by plastic deformation under pressures applied between a narrow roll and a mandrel, formed to the required internal dimensions of the part. The blank or pre-form is held against one end of the mandrel and the roll traverses along a path which follows the mandrel contours and spaced from it at a distance to give the permissible reductions which eventually produce the desired wall thickness.

The process can be divided into three main sections. First there is shear spinning. This is the production of conical shapes with constant wall thickness from an upright blank or pre-form. In this instance, the finished wall thickness is determined by the sine of one half of the included cone angle (see Figs. 4a, 4b). Second there is tube extruding, which is the production of cylindrical components with parallel walls from a shorter, thicker walled pre-form component. This process can be broken down into forward extrusion and backward extrusion, depending on whether the metal flows in front of or behind the roll.

Finally there is contouring—a combination of the first two—in which the deforming roll follows a path parallel to the outside shape of the mandrel under hydraulic or other form of tracer control. The sine law again applies.

Material reductions of up to 75 per cent of the original thickness have been found to be practicable with one pass of the roll, providing sufficient power is available and the machine is rigid enough to withstand the very substantial loads applied without serious deflection. As in all cold forming processes it may be necessary to take several passes with inter-stage annealing operations to restore ductility.

It has been found possible to apply the process to most engineering materials. As would be expected from the type of working, improvement in the strength and hardness of the material is effected at the expense of ductility. The original properties of the metal can be restored by suitable heat treatment, although this may be accompanied by small distortions requiring further rectification.

Considerable attention has recently been given to the use of flow turning as a stage of production of a component rather than as a means of production in itself—utilising, for example, deep drawing and flow turning to produce many designs which would otherwise be impossible to achieve without recourse to fabrication.

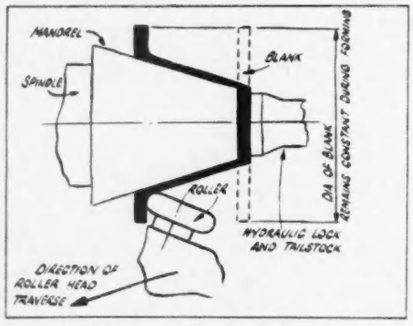

Fig. 4a Flow turning.

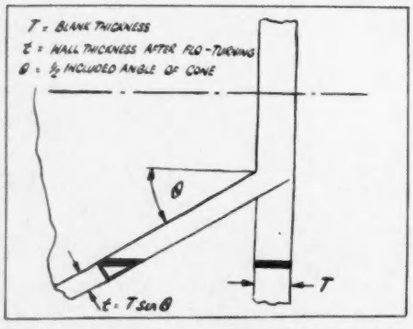

Fig. 4b In flow turning, the finished wall thickness is given by the sine of half the included cone angle.

Today's Trends in the Removal of Metal

The more recently developed methods of machining, including the various methods of electric machining, ultrasonic grinding and chemical milling are reviewed.

By M. M. Barash, Ph.D., Dipl.Ing.

The Faculty of Technology, University of Manchester

MACHINING methods other than conventional methods of metal cutting and grinding form the basis of this article. These methods have largely arisen since the Second World War. In general, they are used to remove modern metals in cases when the conventional methods are either ineffective or uneconomical. They are mostly variants of electric machining, with the exception of ultrasonic grinding and chemical milling.

The electric methods of metal removal can be conveniently divided into spark machining, arc machining, electrolytic machining and electron beam milling. The best known at present is spark machining, and spark eroders have become a familiar machine in the workshop.

SPARK MACHINING

The process of machining by sparks is based on the fact that an electric spark causes erosion on the electrodes between which it passes. The erosion of sparking plug electrodes is caused by sparks and is well known. Research into methods of reducing the erosion of electric contacts has brought the discovery of the highly intensified erosive action of the spark passing through a dielectric liquid, instead of air or another gas. The result of this was that spark eroders were built with the express purpose of removing metal.

The circuit used originally, and still used (though often with modifications) is the RC relaxation circuit shown in Fig. 1. It consists of a condenser C and resistance R, connected to a d.c. source of potential E. T is the tool electrode, W is the workpiece and both are submerged in a liquid dielectric, usually paraffin.

The condenser is charged by the source, and the voltage V across the condenser (and across the electrodes T and W) is given by $V = E(1 - e^{-t/RC})$, where t is the time. When a certain value of V is reached which suffices for breaking down the insulating gap between the electrodes T and W, a spark develops.

The typical voltage and current shapes of a spark are shown in Fig. 2; assuming a breakdown voltage of 100V. The dotted parts may or may not occur, depending upon the conditions in the gap. Of particular interest is the current form—it is a highly damped sine wave, and the amplitude of the first half-wave is often in the order of 1000 A. The spark channel which forms in the dielectric is narrow—a few tenths of mm in diameter, and the current density is therefore very high, up to 10^6 A per sq. mm. This intensive current melts and vapourises a small volume of metal on each electrode, leaving a shallow circular crater on each. The duration τ of the spark is determined by the values of the capacity C of the condenser and the inductance L of the discharge circuit and is very nearly equal to $\pi(LC)^{\frac{1}{2}}$.

If for some reason, the duration of the spark exceeds $\frac{1}{2}$ m sec, it assumes the characteristic of an arc, namely reduction in current density owing to the spread of the channel. The erosive action then reduces, and therefore such long sparks are avoided. The duration of the spark usually varies between a few to a few tens of microseconds.

The erosion rate depends upon the spark repetition rate, which is governed by the resistance R. The lower R, the higher the repetition rate. The value of R, however, must always be sufficiently high to prevent the formation of a continuous arc between the electrodes. Under optimum conditions the charging of the condenser takes 10-20 times longer than the duration

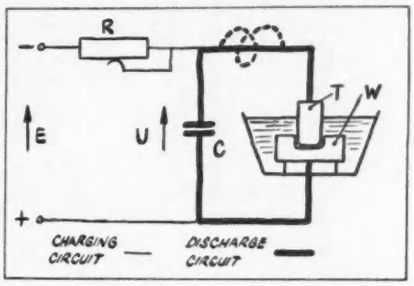

Fig. 1. Spark eroder circuit.

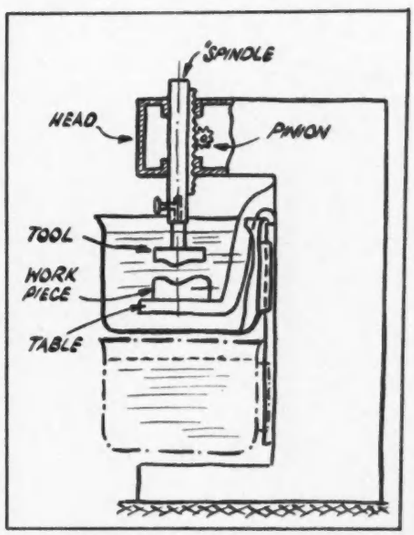

Fig. 3 A spark erosion machine.

of the spark, so that most of the time is "wasted" for charging. This low time-utilisation is the only serious drawback of the relaxation circuit.

The desire to improve the performance of the RC circuit has brought about a multitude of modifications, such as the inclusion of induction coils in one or both parts of the circuit, use of rectifiers, of saturated core reactors and so on. The d.c. source has been modified to half-wave rectifier current or other variant, but all in all, none of these has caused a major increase in efficiency. The maximum rate of removal (hardened steel) attained in roughing is up to 1 cu. cm per min, and in finishing it may be considerably reduced to a few cu. mm per min, according to the surface finish required.

The technological applications of spark machining are very wide and cannot be easily summarised. Perhaps the best, though not complete generalisation is given by stating that the cavity produced by the erosion of the workpiece is a very close replica of the tool electrode. Most commercial equipment is designed for sinking operations, and mechanically comprise a head with a sliding, servo controlled tool holder spindle and a work holding table, submerged in a dielectric liquid. Fig. 3 shows such a machine—the "spindle" is raised or lowered automatically by the pinion, so that the correct gap is maintained between the tool and the workpiece. The workpiece is mounted on a flat, machined table, and the dielectric is kept in the tub. (The design shown incorporates a tub which can be raised or

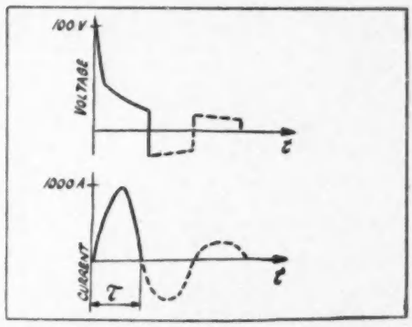

Fig. 2 Typical voltage and current characteristics.

lowered and has been incorporated in a recent machine. It considerably facilitates the proper location of the workpiece). Coordinate movement of the table or the head is sometimes incorporated. The dielectric is filtered and recirculated and, if required, a jet of the dielectric can be squirted into the gap, sometimes through holes drilled in the tool electrode. This flushing of swarf from the gap is beneficial when, for example, deep cavities are produced. A neat idea, sometimes employed for facilitating swarf removal is the mounting of the workpiece above the tool and "sinking" the cavity from below. A standard machine of the type shown can be used for die sinking, for producing circular or non circular through or blind holes in any electric conductor, including sintered tungsten carbide, for making very thin slits and many other operations. The tools are made of an electrically conductive material, and brass or copper are very common. A very useful, though unexplained phenomenon is the low rate of erosion on the cathode compared with that on the anode. A copper cathode (i.e. tool electrode) will lose only 20 per cent of the amount eroded by it from a hardened steel anode (workpiece). Special materials, such as copper impregnated graphite provide even more stable electrodes. Nevertheless, the tool wear has to be taken in account, and in die sinking, for example, several tool electrodes are used in succession in order to complete the operation. Another factor to remember is the gap size—the cavity is a replica of the tool plus the gap "envelope." The gap size depends upon many parameters, but as a rule it is larger with high voltage, and much larger in roughing than in finishing. One or a few thousandths of an inch is the usual gap size, but it can be reduced in very fine machining. A very important factor in spark machining is the almost complete absence of cutting forces.

Spark machining is also employed for less conventional work, such as drilling very fine holes, cylindrical, surface or form grinding, internal screwcutting.

The most economical surface finish in electrosparking will depend on the actual work to be done; 20–30 μ-in can be achieved without undue difficulty, but very much finer finishes, though possible, may take too long to produce. Quite often the final finish is produced by lapping or by hydrabrasion.

ARC MACHINING

Attempts to employ the electric arc for metal removal have been made for many years, but only in the late thirties could real progress be noted. It was then that the "arc disintegrators" started appearing on the scene—devices which could remove broken drills, taps or studs. A brass or copper rod was vibrated

longitudinally using a normal mains frequency operated vibrator. A low voltage transformer produced an arc between the rod and the part to be disintegrated, and the operation was performed under a stream of water. Such devices are still made, but as a rule cannot be termed machine tools, because the "cut" surface is very rough and deeply affected by the thermal action of the arc. To avoid this, arc duration must be drastically reduced, which can be achieved in a number of ways. Small tools (or workpieces) can be oscillated at much higher frequencies, up to 1,000 c.p.s. Arc grinding discs can be serrated in a manner which mechanically limits arc duration. The voltage used is up to 40 V, a.c. or d.c., but sometimes is as low as 0·5 V, if good surface finish is required. Currents up to 500 A are used in roughing. Arc machining of this type is carried out in a hydrocarbon dielectric, and very high rates of removal combined with dimensional accuracy are claimed in literature.

A highly productive method of electro-erosive machining called pulse machining has been recently developed in Russia. Unipolar pulses of 25–200 V are produced at a repetition frequency of 300–600 per sec and, as they are of the duration of several hundred microseconds, they result in arcs rather than in sparks. The pulse generators are either of the gas valve type or rotating machines with or without commutators and the respective pulse shapes are (*a*), (*b*) and (*c*), Fig. 4. The rate of removal is up to 8 times higher than with condenser circuits giving the same surface finish, but generally the pulse machines are better suited for roughing. Paraffin or a similar dielectric is used, but the polarity is reversed—the tool is made the anode and the workpiece the cathode. Tool electrode wear is very much lower than with spark machining, and sometimes can be reduced below 1 per cent. It appears that at least in die-sinking (especially when using carbide die inserts) the use of pulse machines for roughing prior to spark finishing can greatly reduce diemaking expenses.

ELECTROLYTIC MACHINING

As the name implies, electrolytic machining is based on the electrolytic dissolution of the metal to be removed. Several variants of electrolytic (sometimes also called anodic) machining processes are known, but are not widely used as yet. Electrolytic machining can be carried out in conjunction with abrasive grinding, in which case an electrode is used in addition to the grinding wheel (Fig. 5a), or a special electro-conductive wheel is used, in which abrasive grains are imbedded in a metal matrix (Fig. 5b). Graphite impregnated wheels have also been used for the purpose. A weak electrolyte is used, such as a very weak salt solution or a sodium silicate solution. Another electrolytic method uses a mild steel tool, a fast moving band or a rotating wheel, and sodium silicate as the electrolyte solution. Finally, a reciprocating tool can be used for cavity sinking by the electrolytic method.

The electrolytic machining is suitable for hard and in particular for tough metals such as stainless steels and gas turbine blade alloys. Rates of removal in electrolytic grinding or sawing can be very high, up to 0·1 cu. in per min. Several recent models of tool grinders have been adapted so as to enable electrolytic form grinding and sharpening, if necessary. In all cases d.c. is used with the workpiece being the anode.

Voltages of up to 20V, and currents up to 3,000 A (for roughing) are being used in electrolytic maching. The best surface finish attainable with low voltage and current is about 2 μ-in.

ELECTRON BEAM MILLING

A novel method of cutting, which has developed in the last decade is the direct controlled application of a powerful electron beam. For the lack of a better comparison, the method could be called "microminiature flame cutting."

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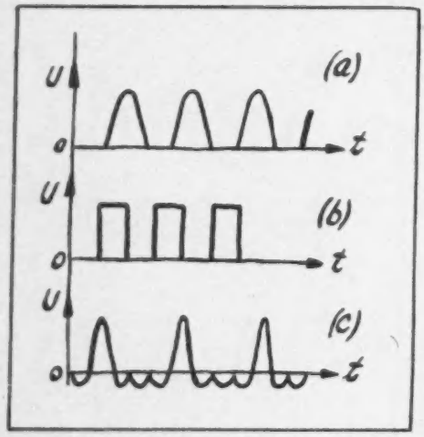

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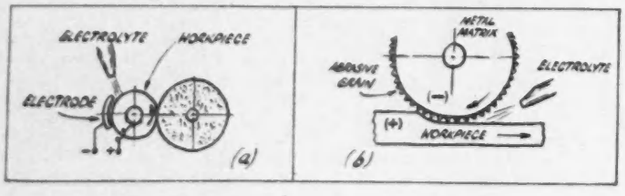

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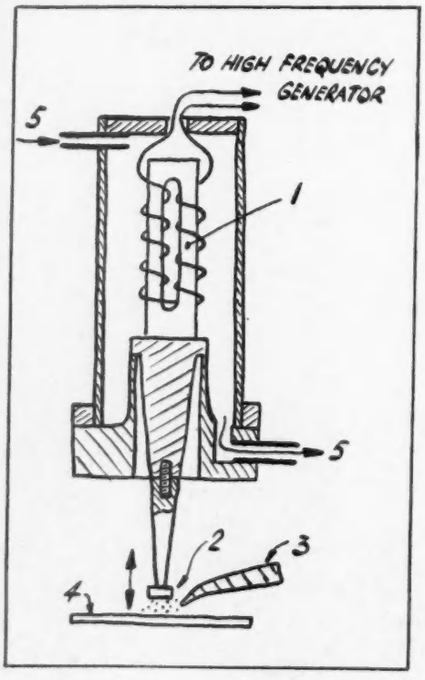

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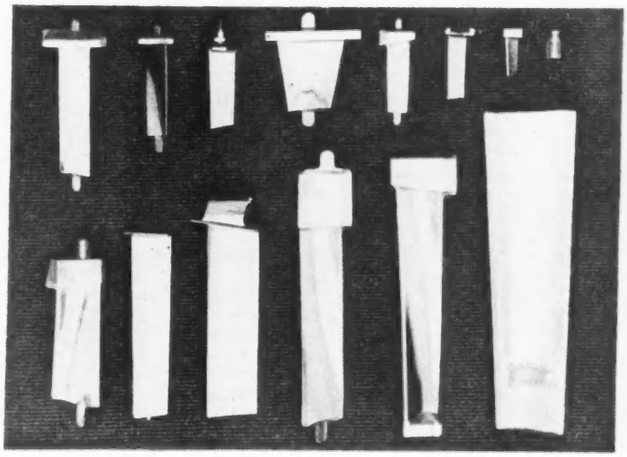

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longitudinally using a normal mains frequency operated vibrator. A low voltage transformer produced an arc between the rod and the part to be disintegrated, and the operation was performed under a stream of water. Such devices are still made, but as a rule cannot be termed machine tools, because the "cut" surface is very rough and deeply affected by the thermal action of the arc. To avoid this, arc duration must be drastically reduced, which can be achieved in a number of ways. Small tools (or workpieces) can be oscillated at much higher frequencies, up to 1,000 c.p.s. Arc grinding discs can be serrated in a manner which mechanically limits arc duration. The voltage used is up to 40 V, a.c. or d.c., but sometimes is as low as 0·5 V, if good surface finish is required. Currents up to 500 A are used in roughing. Arc machining of this type is carried out in a hydrocarbon dielectric, and very high rates of removal combined with dimensional accuracy are claimed in literature.

A highly productive method of electro-erosive machining called pulse machining has been recently developed in Russia. Unipolar pulses of 25–200 V are produced at a repetition frequency of 300–600 per sec and, as they are of the duration of several hundred microseconds, they result in arcs rather than in sparks. The pulse generators are either of the gas valve type or rotating machines with or without commutators and the respective pulse shapes are (*a*), (*b*) and (*c*), Fig. 4. The rate of removal is up to 8 times higher than with condenser circuits giving the same surface finish, but generally the pulse machines are better suited for roughing. Paraffin or a similar dielectric is used, but the polarity is reversed—the tool is made the anode and the workpiece the cathode. Tool electrode wear is very much lower than with spark machining, and sometimes can be reduced below 1 per cent. It appears that at least in die-sinking (especially when using carbide die inserts) the use of pulse machines for roughing prior to spark finishing can greatly reduce diemaking expenses.

ELECTROLYTIC MACHINING

As the name implies, electrolytic machining is based on the electrolytic dissolution of the metal to be removed. Several variants of electrolytic (sometimes also called anodic) machining processes are known, but are not widely used as yet. Electrolytic machining can be carried out in conjunction with abrasive grinding, in which case an electrode is used in addition to the grinding wheel (Fig. 5a), or a special electro-conductive wheel is used, in which abrasive grains are imbedded in a metal matrix (Fig. 5b). Graphite impregnated wheels have also been used for the purpose. A weak electrolyte is used, such as a very weak salt solution or a sodium silicate solution. Another electrolytic method uses a mild steel tool, a fast moving band or a rotating wheel, and sodium silicate as the electrolyte solution. Finally, a reciprocating tool can be used for cavity sinking by the electrolytic method.

The electrolytic machining is suitable for hard and in particular for tough metals such as stainless steels and gas turbine blade alloys. Rates of removal in electrolytic grinding or sawing can be very high, up to 0·1 cu. in per min. Several recent models of tool grinders have been adapted so as to enable electrolytic form grinding and sharpening, if necessary. In all cases d.c. is used with the workpiece being the anode.

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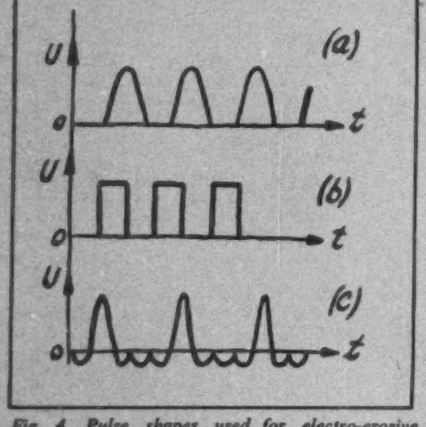

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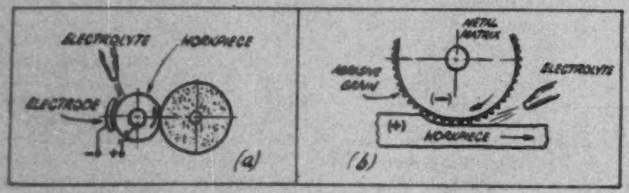

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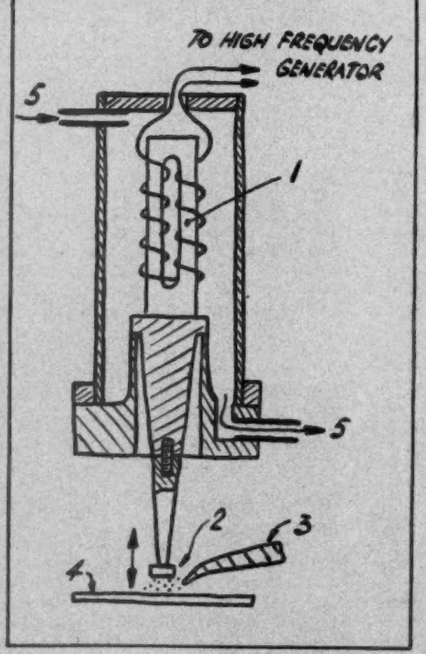

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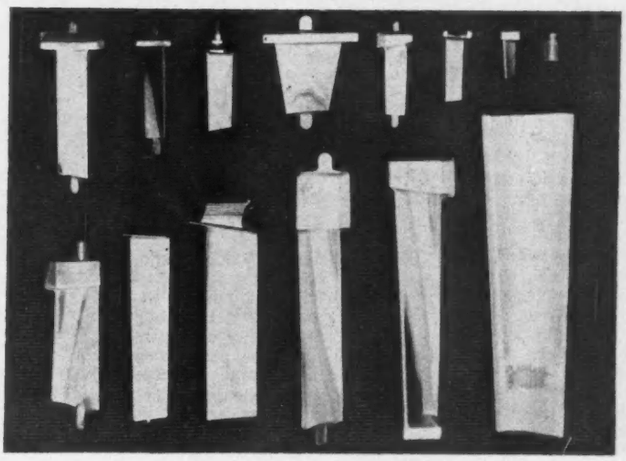

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And we believe that they have an important role to play in the future. A unique feature of our engine range is the very high power-weight ratio.

Recent inquiries and orders could lead to business worth more than a million dollars within two years.

Using Computers in Engineering Design

Electronic digital computers can be used with advantage in general engineering design, and not just for more complex calculations. Application to three everyday design problems is described and discussed.

By C. Storey, B.Sc.

Constructors John Brown Limited

ALTHOUGH it is now widely accepted that electronic digital computers are a useful and reliable tool for the engineer, it seems that they find more application to rather complex special problems than to everyday design calculations. For example, an engineer, faced with the stressing of a complex framework, would almost certainly seek the aid of a machine, while on the other hand he would just as certainly work through the laborious but simple calculations involved in an orifice plate design by hand.

An attempt is made in this article to describe the type of routine design calculation suitable for use on a machine, and to illustrate the actual programming by three examples written to carry out calculations on: the flow of oil between two pumping stations; pressure vessel flange design; and orifice plate design.

Suitable Problems

In the first place consideration is restricted to those well established design procedures constantly used in the various branches of engineering. The steps in the calculations will have been reduced to a combination of chart reading and simple arithmetic but, even so, a single complete calculation may take up to two or three hours of a man's time. It is necessary, of course, that the calculations should be carried out sufficiently often to make the saving in time achieved by running them on a computer worth while. Once a programme has been written it is possible to make a good estimate of computing time, and since the cost of hiring time on one of the computing service machines is known (between £20 and £75 per hour according to the speed and size of the machine), the economics of machine and hand calculations can be compared. Thus a reduction in time from two man days to, say, 10 minutes of machine time (this being a typical reduction) is economically sound. However, not only is the actual time saved important, but also the fact that many extra cases can be considered which would normally have been precluded because of the work involved. Thus the engineer's time can be given to the task of examining the results and using his experience to interpret them, while the drudgery is borne by the machine.

It is seen then that any design routine consisting of simple repetitive calculations and graph and table readings, which is used sufficiently often, would be suitable to run on a machine. Good examples of such routines are the design of tube plates, orifice plates, pressure vessel flanges, the flow of fluids in pipes, the design of heat exchangers, sizing of safety valves, bending and vibrations of beams and so on.

Programming

Most of the computing machines available on a service basis are now equipped with automatic coding. That is to say, expert programmers have constructed master programmes which when read into the machine enable it to obey direct mathematical instructions of the form $a = b + c$, $a = b \div c$, and $a = \sqrt{b}$. It is possible to learn to use such automatic codes including the simple rules whereby cycles of operations can be carried out, in two or three days at the most. On the other hand, a course of two weeks duration is necessary to learn the real language of the machine, and even after this time it takes considerably longer before proficiency is reached.

The automatic codes, therefore, are a suitable medium for writing the design programmes considered. Since they are written in floating point form it is not necessary to scale the calculations as in straightforward machine language. A further advantage is the ease by which they can be altered to take account of changes and afterthoughts in the design. The main disadvantage of automatic coding rests in its inherent slowness, each instruction consisting of several machine code orders; but once a programme has been fully developed and is unlikely to undergo further change it can then, if it is used sufficiently often to warrant it, be rewritten wholly or partially in machine-code. The actual difference in speed between the two methods of programming varies with the problem. For example, if most of the time is spent in reading into or out of the machine, the times show little difference, whereas if most of the time is spent in calculation, the machine code may be as much as 20 times faster. Programme development and testing is very much easier using only the automatic codes and a programme taking two or three months to complete in machine code will generally only take about two weeks in the former.

As an example of the use of automatic codes the programming of the calculation of flow of oil through a pipe line is considered.

FLOW OF OIL BETWEEN TWO PUMPING STATIONS

Although this is rather a simple example it will be described in considerable detail since it illustrates most of the important concepts.

In the design of a pipeline, once the sites and characteristics of the pumping stations have been fixed it is necessary to calculate the flows of a number of products between pairs of adjacent stations. Though the work involved is extremely simple it has to be carried out many times for differing conditions, and hence is laborious. Thus a computer programme is justified.

The design data consist of:—

prevailing temperature	θ
pumping head	P
elevation of 1st station ..	A
elevation of 2nd station	B
receiving head at 2nd station	R

and also the lengths and sizes of the various sections of pipe between the stations. The actual calculation proceeds as follows.

The total "head for friction" H, is calculated from:—

$$H = xP + A - B - R \quad . \quad (1)$$

where $x = \dfrac{231 \cdot 184}{\rho}$ and ρ is the specific gravity of the fluid. The equivalent length of 10 in diameter pipe, C, is now calculated, then the flow in (imperial) gallons per day, F, is obtained from the formula:

$$F = \left[\frac{C \times 10^{9 \cdot 77}}{69331 \times V^{0 \cdot 25}}\right]^{\frac{1}{1 \cdot 77}}$$

where V is the kinematic viscosity. It is also useful to calculate the flow in millions of tons per year, and this is given by:—

$$Q = 2{,}345 \cdot 76 \times \rho \times F$$

In carrying out these calculations by hand, use is made of graphs of specific gravity and kinematic viscosity against temperature for the liquids considered. In the computer programme an expression of the form $\rho = \alpha\,\theta + \beta$ has been fitted to the data on specific gravity and an expression of the form

$$\log(\rho V) = \left[\frac{\gamma}{\theta + 460} + \delta\right]$$

has been fitted to that on kinematic viscosity. At the time this programme was written only three sets of the constants α, β, γ and δ were used, namely those for motor spirit, kerosine and gas oil, but the constants for other fluids are easily introduced. It is not always possible to obtain such a simple fit to experimental relations, and therefore it is sometimes necessary to read a table of values into the machine and to use an interpolation routine. An example of this is given later.

It is possible with some autocodes to write an expression such as (1) directly as it stands; whereas in others only one operation can be written at a time on the right hand side and the procedure would then be as follows:—

$$H_1 = x \times P$$
$$H_2 = H_1 + A$$
$$H_3 = H_2 - B$$
$$H = H_3 - R$$

The actual programme would consist of a series of such instructions, the net result of which would carry out the flow calculations. For example, the calculation of $V^{0 \cdot 25}$ would take the form:—

$$x_1 = \log V$$
$$x_2 = 0 \cdot 23 x_1$$
$$x_3 = \text{Exp}.x_2$$

where x_3 is the required value.

Once the calculation is completed for motor spirit, a "conditional jump" instruction at the end of the programme causes it to be repeated with the constants appropriate to kerosine, and then again for gas oil. It would also be possible to arrange the programme so that the relevant constants were chosen by putting a preset constant in the input data.

The conditional jump instruction mentioned in the previous paragraph is merely a device for interrupting the sequence in which the instructions are obeyed. Thus the jump instruction will cause the machine to obey any previous instruction if a specified condition is satisfied, and to obey the instruction immediately following the jump instruction if the condition is not met. The instruction to which the jump is made is identified by a number called a "label."

With the programme in its present form, for a given set of data the machine will print out the flow of the three products, kerosine, gas oil and motor oil in gallons per day and in millions of tons per year. The results are printed in floating point form with one digit before the point and three after it. Because the calculations are short and very uncomplicated computing time is extremely short. An idea of the speed of the programme can be obtained from an example in which flows of three products at three different temperatures and for a pipeline with eight pumping stations were calculated. By hand the calculations had taken between 2 and 3 man-weeks and by machine the time was between 3 and 4 minutes.

FLANGE DESIGN FOR A PRESSURE VESSEL

As a second illustration of the use of computing machines, a brief description follows of a programme written for pressure vessel flange design, based on the procedure given in British Standard 1500 : 1959 "Fusion Welded Pressure vessels." The diagrams in the standard are represented in the programme by the original expressions from which they were formed, except in the case of the relaxation constant Δ which is, of course, experimentally derived, see Fig. 1. In this case the range of temperature has been broken into three intervals and Δ represented by a constant over the first interval, a quadratic expression over the second and a pair of straight lines, one for carbon and one for mild steel, in the third interval.

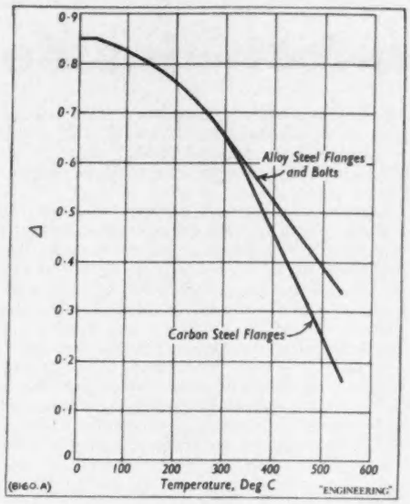


Fig. 1 Curves for relaxation constant Δ.

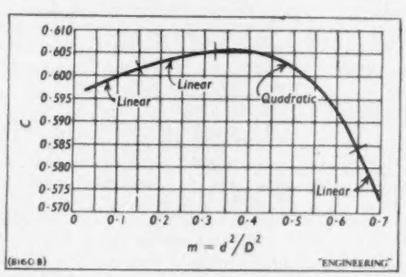


Fig. 2 Curve for coefficient of discharge C.

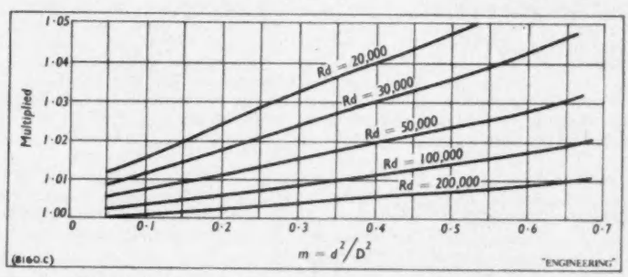


Fig. 3 Correction curves for Reynolds number R_d.

Care has been taken that the data required for the programme consists only of the fundamental details of the problem and a few organisational constants. To illustrate this the form of the input data is given in full:—

1 Design pressure in lb per sq. inch.
2 Design temperature in degrees Centigrade.
3 Test pressure in lb per sq. inch.
4 Inside diameter of vessel at flange in inches.
5 Shell thickness adjacent to flange in inches.
6 Fillet weld leg size at back of flange in inches.
7 Radial thickness of taper hub at junction with flange in inches.
8 An assumed bolt size in inches diameter.
9 Gasket seating pressure in tons per sq. inch.
10 A constant { ¼ for gaskets not in recesses and flanges without collar bolts; ½ for recessed flanges.
11 A constant { 1·75 for compressed asbestos fibre gaskets on vessels up to 24 in diameter. 2 for compressed asbestos fibre gaskets over 24 in diam. 1 for flat solid metal or metal jacketed asbestos gaskets.
12 A constant which when multiplied by bolt size gives edge distance.
13 A constant { 1 for mild steel 0 otherwise
14 A constant { 1 for carbon steel 0 otherwise
15 A constant, the amount by which the bolt size is reduced or increased in successive iterations (usually about 0·125, but could be larger for larger bolts).
16 A constant, the amount by which the tentative thickness is changed in successive iterations (also usually about 0·125).

On being fed with such a set of data the machine proceeds as follows. The outside diameter of the flange is calculated by adding a constant multiple of the bolt size to the pitch circle diameter (this constant is given as approximately 2 in *Taylor Forge Bulletin 502* and about 4 in BS 1500). The next step is the calculation of the number of bolts, this being carried out for conditions of initial tightening, design pressure and test pressure, a separate result being obtained for test pressure when the bolts are of mild steel. The largest of these three or four results is increased to the nearest multiple of four, and this is taken as the required number of bolts.

The tentative flange thickness is now calculated and subtracted from the greatest of the three more accurate values of thickness. The constant mentioned in (16) above is added to or subtracted from the tentative thickness according to whether this difference is positive or negative, and the whole process repeated until the sign of the difference changes.

Finally a check is made to see that the chordal pitch lies within the limits 3d and (3·5d + 0·5T) where d is the bolt size and T the tentative flange thickness, both in inches. Should this condition not be satisfied a constant amount (see 15 in the list above) is added to or subtracted from the bolt size. The complete calculation is now repeated until the pitch does lie within the limits.

In its initial form the programme printed out the bolt size, number of bolts and flange thickness at each iteration on the bolt size and stopped as soon as the chordal pitch requirements were satisfied. It was found that the results showed considerable variation according to whether the limits were approached from above or below. For example, in a design in which 56 bolts of 1 in diameter were satisfactory, the machine produced an answer of 76 bolts of 0·875 in diameter on assuming a bolt size of 0·5 in and, on the other hand, gave 48 bolts of 1·125 in diameter when 2 in was the initial assumption.

Because of this the programme was altered so that it only printed out results satisfying all the requirements but included all such designs. Thus the engineer is able to compare those designs which are mechanically sound and choose the one which best conforms to other relevant conditions.

Considerable thought was given to the possibility of using this programme to produce a set of tables of flanges for varying conditions of pressure, wall thickness, vessel diameter etc. To cover the useful range of variation of the important variables using sufficiently small intervals, the cost of such a venture would have been prohibitive.

The time taken to carry out a calculation varies of course with the number of iterations that take place, so that the better the initial guess at the bolt size the shorter the time. The average time is about 2 or 3 minutes and as a good part of this is taken up in reading the programme it is better to do a number of designs at the same time.

ORIFICE PLATE DESIGN

This is used as a final example, and the calculations on which this programme is based are to be found in British Standard 1042 : 1943, "Code for Flow Measurement." The programme is capable of calculating rate of flow through a pipe, with its diameter, the throat or orifice diameter and the pressure differential given; or of calculating throat or orifice diameter when the rate of flow, etc. is given.

As before, exact theoretical expressions have been used instead of charts where possible, otherwise least square curve fitting has been used. It is interesting to notice that the rather complex "long range mE calculating chart" is represented by the very simple formula:—

$$E = \frac{1}{\sqrt{(1 - m^4)}}$$

Such instances are not at all infrequent in design calculations, and, of course, are of tremendous help in the programming. In one case, the coefficient of discharge, it was necessary to split the range of variation into a number of intervals, over each of which a relatively simple expression could be fitted, see Fig. 2. Again, in the case of the correction factor for Reynolds number, even more difficulty was experienced in curve fitting and eventually it was decided to use tabular values and interpolation, see Table and Fig. 3. The actual correction factor is a function of both Reynolds number and the ratio of throat area to pipe area and so a double entry table with interpolation in two directions had to be used. Because of the form of the functions involved it was necessary to use different step lengths for different parts of the ranges of the variables.

One of the difficulties in writing a programme of this nature is deciding how many different conditions to include. For example, to include the effect of the variation in the compressibility coefficient for different gases would entail considerable extra curve fitting for only a slight increase in the usefulness of the programme. It is thus better, in such cases, to let the designer read the appropriate chart and give the corrected density as part of the input data. Another important point in this respect is that the longer the programme becomes, the slower it becomes (mainly because input to the machine is slow); thus increased versatility due to the inclusion of wider sets of conditions must be balanced against this decrease in speed.

The results of the calculation consist of a print-out of either the flow correct to one decimal place or the diameter to four places with the overall tolerance to four decimal places given in each case. Running time for a single calculation is of the order of 4 minutes, but a set of 12 calculations take only 7 minutes. This again illustrates the benefit of running a set of designs on the same occasion.

The author's thanks are due to Mrs. J. M. Hilton and Miss D. Newsome for help in writing the programmes and to the directors of Constructors John Brown Limited for permission to publish this article.

TABLE.—*Corrections for Reynolds number R_d*

m \ R_d	20,000	30,000	40,000	50,000	60,000	80,000	100,000	200,000
0·05	1·012	1·009	1·007	1·006	1·005	1·004	1·003	1·001
0·1	1·016	1·012	1·009	1·007	1·006	1·005	1·004	1·001
0·15	1·020	1·014	1·011	1·009	1·0075	1·006	1·005	1·002
0·2	1·024	1·017	1·0135	1·011	1·009	1·007	1·006	1·002
0·25	1·028	1·021	1·017	1·013	1·011	1·0085	1·007	1·003
0·3	1·033	1·024	1·019	1·015	1·013	1·010	1·008	1·004
0·35	1·037	1·027	1·021	1·017	1·015	1·012	1·010	1·005
0·4	1·040	1·030	1·024	1·019	1·016	1·013	1·011	1·006
0·45	1·044	1·033	1·026	1·021	1·018	1·014	1·012	1·006
0·5	1·048	1·036	1·029	1·023	1·020	1·016	1·014	1·007
0·55	1·051	1·038	1·0305	1·025	1·022	1·0185	1·016	1·008
0·6	1·055	1·042	1·033	1·027	1·024	1·020	1·017	1·009
0·65	1·060	1·047	1·037	1·030	1·026	1·022	1·019	1·010
0·7	1·063	1·050	1·040	1·033	1·029	1·024	1·021	1·011

Achieving the Air of Comfort Inside

A comfortable car has an interior temperature independent of climatic conditions. In Britain ventilation and car heaters are used to this end. Air conditioning gives greater control and also removes dust.

IT COULD be argued that the prime function of a car is to convey its occupants safely to their destination, with the qualification that the conveyance should be comfortable. In fact, comfort of the driver contributes to safety. Or, to be more precise, discomfort distracts, and distraction at the wheel is dangerous. Psychologists point to other major functions that a car fulfils, notably (*pace* Freud) that of a prestige symbol, a badge of wealth. And in this, too, comfort has its part to play.

Air temperature and purity, and the temperatures of the occupants are important influences on comfort. The degree of control exercised over them varies considerably. One of the simplest controls is the choice of car body colour. In hot summer conditions, light or reflective paints produce some benefit. Interiors of cars parked for an hour in the sun can be 15° F cooler if the car is light rather than dark in colour. And the lower temperature of seat, steering wheel and door that results is appreciated by drivers as they enter the car. When the car is moving, however, roof metal temperatures show only 2 to 3° F difference between black and white paint, and no advantage is felt.

The effect of various types of thermal insulation between the roof and head lining have been examined, but no conclusive results have been obtained. Floor insulation is useful when the car is heated or air conditioned.

The low insulation-value glass areas in a car have considerable influence on the heat balance of the occupants, and normally allow radiant heat to pass through with ease. Clear glass transmits up to about 80 per cent of the incident radiant heat, but a distinct improvement for perspiring occupants can be obtained by the use of selected materials that transmit only a quarter of the radiation. In addition to reducing the radiant heat load on the occupants, shaded or tinted glass can lower inside car temperatures by as much as to 5° F.

During the summer, seat materials influence comfort. Seat covers of non-breathing material do not allow for evaporative cooling of the skin followed by reduction of skin temperatures.

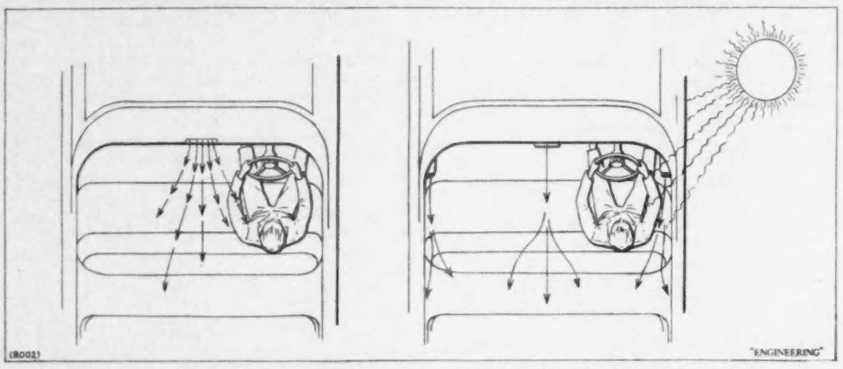
HEATER

The variables mentioned above can be used to exercise some control over the comfort of a car, but there is an increasing demand for more positive control by better ventilation and by heating or cooling the air entering the car. One step in this direction is the use of a car heater, and there has been a noticeable increase in the use of such units in Britain. Complete air conditioning, involving refrigeration equipment, is very rare in Britain, but is becoming increasingly popular in the United States where the climate and long distances make it better appreciated.

The installation of a heater in a car represents a partial solution to the problem of air temperature control; it leaves summer temperatures in the car to be adjusted by window draughts, or, sometimes, correctly designed ventilators. Unfortunately, although the flow of air through a partially opened window is at approximately the right height for effective cooling in response to strong heat loads, it affects one side of the face only, and feeds noise into the car, as well as dust and pollen.

The different patterns of air flow required in a car in summer and winter for optimum comfort have been described by Mr. W. H. Jackson, General Motors Corporation, in a paper "The Bodies in Which We Live," read during the National Automobile Week of the Society of Automotive Engineers.

For ambient temperatures from 0° F to 70° F, the heater outlet temperature should vary from 160° F to 70° F. To provide adequate heat under severe ambient conditions, and rapid warming of internal surfaces, a maximum of 25,000 Btu per hour is required. Discharge of the heated air should be at or near floor level. The rising hot air gives good heat distribution throughout the car and the initial discharge around the legs and feet (the least clothed and lowest skin temperature portions of the body) provides a psychological warming effect during the early stages following starting. Discharge of hot air towards the face would be undesirable, as it would dry out the mucous membranes of the nose and throat, causing discomfort.



When the body is subjected to an unbalanced heat load, cool air should be directed to hot areas, as shown in the right hand car. The air flow in the left hand car only increases the unbalance.

In warm weather, cooling can be achieved by letting air at ambient temperature flow over the skin surfaces. The process can be rendered more efficient if the air is cooled.

Skin temperature is the most important influence on heat transfer rates to and from the body. In general, 44 per cent of body heat is lost by radiation to colder surfaces, 32 per cent is lost by convection to the air from the skin and mucous surfaces of the nose and throat, and 21 per cent is lost by evaporation from the skin and the same mucous surfaces. The remaining 3 per cent is used for warming food and for various digestive processes. A thermally comfortable individual might have skin temperatures of 80° F at the toes, 90° F at the upper legs and arms, 95° F at the forehead, and a constant deep body temperature of about 100° F. Once the skin temperature reaches 95° F, however, the entire body surface tends to stabilise at this value as ambient temperatures increase.

It is worth mentioning at this point, that while these general considerations can be used as a guide to design in cars, data on "effective temperature" for human beings—developed so that the effect of temperature, humidity, and air movement should be expressed as a single figure—is not applicable. Effective temperature data are concerned with fairly large compartments having wall temperatures nearly the same as air temperatures. A car constitutes a small compartment, of about 150 cu. ft at the most, and has large areas of glass that are cold in winter and hot in summer.

Car ventilation operates usefully at ambient temperatures between 60° F and 100° F. The cooling achieved depends on the evaporative heat loss from the passengers resulting from the impingement of air at velocities between 50 and 1,100 ft per min. For ventilation purposes an air flow of 500 cu. ft per min is quoted by Mr. Jackson as being the optimum, compared with 150 cu. ft per min for heating and 250 cu. ft per min for air conditioning. Naturally, air humidity greatly influences the cooling effect of the air flow, but this is not controlled unless refrigeration is present.

Ideally, ventilating air should flow over the occupants in an upward direction direct from the feet, with higher velocities on the feet and lap. Air speed should be reduced at chest level and should be very low at the face. If air is brought in below the instrument panel and exhausted through controlled ventilators and windows at about shoulder level, a good approximation to the ideal distribution can be achieved. In addition a relatively small quantity of air should be delivered to the front floor of the car to provide foot cooling and to counteract the radiation of heat from the dashboard, toe pan and floor pan to the lower legs and feet. Parts of the body warmed by the rays of the sun require distribution of air to them to increase the evaporative cooling effect and offset the radiative heat gain of the body.

AIR CONDITIONING

The insertion of a refrigeration unit into the ventilation air line produces a system capable of a greater range of control over car internal temperatures. Such air conditioning is useful for ambient temperatures between 100° and 70° F, when the injected air should be at between 40° and 70° F. It is found that a peak cooling rate, under high temperature, humidity, and sunshine, of some 22,000 Btu per hour is required. Refrigerated air velocities up to 1,500 ft per min are used.

Refrigerated air distribution calls for considerable flexibility to meet the requirements of comfort. Initially the system must direct cooled air on to the lap, chest, and face of passengers. But as heat is lost from the occupants and the internal car surfaces, the discharge of cool air needs to be adjusted so that the internal car surfaces continue to be cooled but the occupants no longer have the initial high rate of cooling.

Care has to be taken that the inboard side of front-seat passengers is not overcooled while the outboard side is being overheated by solar radiation. Such an unbalanced heat input is uncomfortable, as the body has difficulty in correcting the condition. Air discharge nozzles therefore have to be arranged so that a flow of cool air is present on both sides of each of the front seat occupants.

Sufferers from hay fever benefit considerably when an air conditioning unit is installed. It turns out that the wet evaporator is 98 per cent efficient in removing air-borne pollen, and the emergent air in the passenger compartment causes no hay fever discomfort, even at the height of the hay fever season. Unfortunately the system is not so effective in removing concentrations of exhaust fumes met in traffic.

Calibrating a Compensating Type Balancing Machine

By J. A. Macinante

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A general method of calibrating dynamic balancing machines, not requiring the use of a " perfectly " balanced test rotor, was previously described in ENGINEERING[1] with particular reference to resonance-type machines. This method has now been used for a " compensating " type of machine.

The compensating machine incorporates means of applying a counter-vibration at the bearings supporting the rotor being balanced. This is adjustable in amount and phase so that it can nullify the effects of the unbalance of the rotor. The compensating head is adjusted to give a zero reading on a meter which indicates the bearing vibration, and the unbalance is read off " amount " and " angle " scales associated with the compensating head.

With the resonance machine, the calibration relates the true unbalance (mass times radius in a given balancing plane), with the machine reading of the bearing vibration. The latter depends on the amount of unbalance. The compensating machine differs in that the bearing vibration meter serves as a null indicator, and the calibration relates the true unbalance with the direct reading of unbalance derived from the mechanical setting of the compensating head. The true unbalance is evaluated as the vector sum of the initial and added unbalance as detailed in the earlier article.

It is not necessary to complete the observations which determine the initial unbalance before starting on those that relate the compensating-head reading to the known unbalances. On the contrary, since much time is taken up, especially with large rotors, in bringing the rotor up to speed after changing a test mass, and in bringing it to rest in order to make the next change, a procedure is adopted whereby the compensating-head reading is taken for each of the unbalance conditions imposed for evaluation of the initial unbalance. All observations are made while the test rotor is rotated at a given speed, which is the constant speed of operation of the machine for normal balancing.

CALIBRATION TECHNIQUE

The steps for calibration are as follow:

(1) With zero " amount " applied by the compensating head and with a suitable test unbalance, T_1, at some angular position (A) in a given balancing plane, an observation is made of the bearing vibration displacement. This is done with a vibration measuring instrument independent of the machine, or with the vibration meter of the machine itself, if the accuracy and range of that meter are suitable. If the machine meter has multiple sensitivity ranges, readings must be taken on several ranges, for if one range is chosen to suit the first observation, the meter reading may be off scale or too low when the test mass is in another position.

(2) Using the machine in the normal way for balancing, the compensating head is adjusted until the meter reads zero, and the " amount " on the machine scale is observed.

(3) Operations (1) and (2) are repeated for the other three conditions which are used to determine initial unbalance; that is test unbalance T_1 at positions B and C (120 and 240 degrees respectively around from A), and with no added unbalance[1].

(4) A series of test unbalances T_2, T_3, etc., are added in turn at one position, e.g. (A). For each such unbalance condition, the machine is operated in the normal way for balancing, and the machine reading of the unbalance observed. In choosing the test unbalances, most attention must be given to the lower end of the scale, i.e., the small amounts of unbalance, because the performance of the machine is judged mainly on the minimum amount of unbalance it can detect.

(5) The true unbalance values are evaluated by the graphical addition of the initial and added unbalances, as detailed in the earlier, articles[1, 2] and include any necesssry correction for the axial separation of the balancing plane in which the test masses are added, from the bearing plane in which the machine compensation is applied.

SUPPLEMENTARY EVALUATION

In taking the observations for items (1) to (3) above, four machine readings of " amount " of unbalance are obtained with the test unbalance T_1 at A, B, C and with no added test mass. These four quantities, corrected if necessary in the light of the foregoing calibration of the " amount " scale, can be used to make a supplementary graphical evaluation of the initial unbalance. This can be looked upon as an overall check on the work.

The foregoing instructions relate to the calibration of the " amount " scale of the machine for unbalance at one end of the rotor, and the procedure is repeated for the other end. The calibration applies specifically to the machine as set up for a particular test rotor, and the entire procedure is repeated, if necessary, with other rotors; for example, it may be necessary to determine the sensitivity of the machine as set up for minimum and maximum weight rotors.

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[2] Somervaille, I. J., " Balancing a Rotating Disc," ENGINEERING, p. 241, vol. 177, 1954.

New Set-Up for Conveyor Belt Research

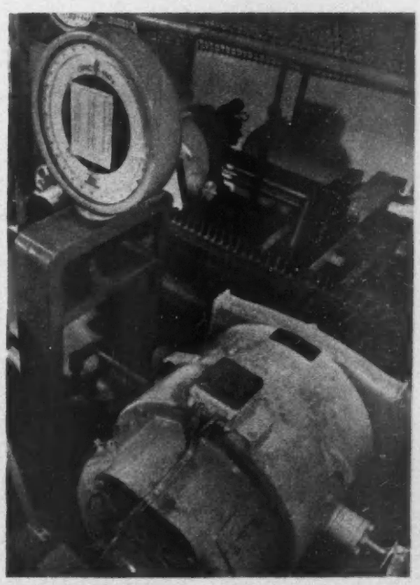
In recent years, great strides have been made in the materials and construction of belts for transporting goods and transmitting power. As a result of this there is now a much larger variety of belts available to industry and the techniques of producing them have become highly complex.

In order to keep abreast of both the requirements of industry and new developments in materials, the Belting Division of the Dunlop Rubber Company has now set up an organisation for research and development. It is based on a recently completed laboratory at the company's Speke factory in Liverpool. These new facilities not only enable advantage to be taken of developments in materials and processes, but also reinforce factory production control to ensure a consistently high standard of quality in the end product.

A large proportion of the Belting Division's output is consumed by the National Coal Board, who themselves have extensive research facilities for testing and specifying belt designs. Because of their close liaison with the NCB, who have a great amount of applicational experience in both transmission and conveyor belts, the Dunlop Company have decided to restrict their facilities largely to laboratory sample tests. In this respect, tests can be made of all the properties of belts which are known to be correlated to efficient practical use.

Among the properties that can be examined are: tensile strength and elongation, using an Amsler machine which can apply a load of 30 tons to a sample piece; impact resistance, which is tested on a pendulum machine developed in the Dunlop laboratories; adhesion resistance, measured on a Hounsfield tensometer; tear resistance, also measured on a Hounsfield tensometer, but with additional facilities fo greater accuracy; and non-static properties, which must be measured on all pvc covered belts to ensure that static electricity cannot build up on the surface and give rise to a spark.

In developing new forms of industrial belting, full use is made of these test facilities, but in addition, further apparatus is available for small scale production and dynamic testing. One of the largest pieces of equipment used for this development work is a specially designed dynamometer rig. This contains a 25 h.p. dynamometer which enables the power transmission and driving characteristics of belts to be evaluated, and fatigue and friction tests to be made. The illustration shows the rig being used to test the endurance of a new fluted-edge belt that has been developed for carrying loose particle goods. The generator can be seen in the foreground of the picture and the driving motor in the centre background. Output from the generator is boosted and fed back to the driving motor. Torque is measured from the casing of the motor, which is on floating bearings. At a later date, it is hoped to enlarge these facilities by installing an 800 h.p. machine.



A dynamometer rig can be used to measure friction and to evaluate the power transmission, driving and fatigue characteristics.

Direct Approach to Industry's Problems

Research at the National Engineering Laboratory has now taken a new turn, one which is soon expected to have a favourable impact on industry in general, and on the machine tool industry in particular.

The Steering Committee, under the chairmanship of Sir Frank Mason, has just announced what amounts to an entirely new philosophy of approach for the National Engineering Laboratory. With the object of getting practical research data into industry at the quickest rate and in the spots where it can be most usefully applied, the Committee have decided to narrow their programme considerably. In the annual report, now available from HMSO, the Committee point out that priority should be given to "projects which are directed towards immediate industrial problems. "This has given rise to a number of difficult decisions in dropping or deferring interesting research and development work; however, the Committee believe that by adopting the new approach "the gains will be considerable."

To take care of the short-sightedness of a narrow programme which is geared to immediate practical problems, the Committee have recommended that some of the effort available at NEL should be kept on longer term research, although even in this context the importance of practical objectives is stressed.

MACHINE TOOL CONTROL

In determining the programme for the coming year, the Committee laid emphasis on three projects, in particular: investigations in the machine tool field, the development of hydrostatic power transmissions, and work on the cold extrusion of steel. The last item is said to be reaching the stage where its value to industry will be so clear that there will be no need to continue the work at NEL at the present rate.

An example of the effort already being made at NEL, in the field of machine tools, is the use of moiré fringe techniques for highly accurate positional control. A system, developed jointly by NEL and the National Physical Laboratory, has been used to measure continuously the errors in relative motion between various components of a gear hobbing machine and it has well established that it is possible to increase the accuracy of a machine by feeding error signals through a servo system and correcting mechanisms. In an experimental rig at NEL, incorporating a worm and worm-wheel drive, errors in transmission of uniform relative motion have been reduced by a factor of 20.

Use has been made of this system by David Brown Industries Limited in the final drive table of a 30 in gear hobbing machine. This machine, together with some of the highly accurate gears produced on it, is currently on show at the International Machine Tool Exhibition at Olympia.

Moiré fringes are a type of interference band, produced when two similar scales or gratings are placed close together with the lines of each scale not quite parallel. If one scale is moved at right angles to its lines, the fringe pattern moves along one whole fringe as the scale moves one whole spacing. The variations in brightness as the fringes move can be detected with a photocell. Angular movement can also be measured by using radially ruled gratings; movement of one fringe then corresponds to the rotation of one radial division. This gives an accurate and convenient method of converting any change of position or angle into an electrical signal.

Great accuracy is obtainable by these methods since the fringes are produced by an averaging process from very many accurately spaced grating lines. Another advantage is that the gratings do not wear, so that errors in the product caused by wear of a lead screw or gear no longer arise. In addition to their application to machine tool control, moiré fringe methods can be used for straightforward angular or linear measurement.

Errors in rotation of the work table of a gear hobbing machine relative to that of the hob spindle have been measured by two pairs of radial gratings: one pair attached to the work table and the other to the spindle, each with a photoelectric measuring head fixed near it, The ratio of the line spacings in the two pairs of scales was the same as the displacement ratio of the table and the spindle. The phase relation between the two photoelectric signals was recorded continuously on a chart to give both the error in relative motion and, after analysis, the source of error.

LEAD SCREW ERRORS

Automatic checking of pitch errors in lead screws up to 18 ft in length has also been achieved using the moiré fringe technique. On the NEL apparatus, the screw is mounted above a horizontal precision girder along which is driven a carriage mounted on air bearings. On the carriage is a 36 in grating. A smaller grating of equal spacing and an optical reading head is fixed to the girder. As the carriage travels along the girder parallel to the screw, a chart record is produced which gives the error of each flank with an accuracy of 0·0001 in. By using a similar arrangement the displacement of a carriage or any component moving in a straight line can be measured to 0·0001 in over 10 in.

A photographic method for producing circular gratings quickly and accurately has recently been developed at NEL. Such gratings have previously been prepared by a circular dividing engine which rules radial lines through a metal coating on a glass plate. With such a machine a maximum spacing error of two seconds of arc is achieved. However, it is a lengthy process, taking about ten days to rule a 30,000 line scale.

The new photographic technique requires only a section of scale to be ruled in this way. This is mounted above the table of the dividing engine. A photographic plate is then mounted

Automatic measurement of dynamic errors, using the moiré fringe technique, has been demonstrated on a gear hobbing machine.

An apparatus has been developed for the automatic measurement of pitch errors in lead screws up to 18 ft long.

close to and concentric with it so that the plate can be rotated by the table mechanism of the dividing engine. After exposing the plate, it is rotated accurately through one or more spacings, and this is continued until all the lines have been overprinted the same number of times.

This technique eliminates short term periodic errors, giving a greater accuracy than that of the ruled gratings. In addition, wear of the cutting tool is no longer a problem, and the time of preparation is greatly reduced. By this method a 30,000 line grating can be produced in three or four hours.

HYDROSTATIC TRANSMISSION

Two types of hydrostatic transmission of simple and economic construction are currently being developed at NEL. One is a highly efficient unit, which is exceptionally quiet and is suitable for use in ships and heavy road vehicles. The other is a cheaper unit for applications such as machine tools, where high efficiency is less important than a smoothly variable speed/torque characteristic.

There has been an increasing demand in recent years for a steplessly variable hydrostatic transmission having high power-to-weight ratio, quick reversing, and driving and driven units that can be placed separately. A great advantage of such a transmission is that it enables the prime mover to work continuously under the most economical operating conditions. It also eliminates gear trains and shafts and brings the promise of single lever control of the power drive. All these factors make hydrostatic transmissions particularly suitable for ships, aircraft, agricultural machinery, heavy road vehicles and machine tools.

One development of this technique for machine tools has been a radial cylinder hydrostatic transmission, in which the usual pistons have been replaced by reciprocating balls. The balls move in a race eccentric to the driving shaft, which is a pintle valve, and variable displacement is achieved by moving the eccentric relative to the shaft centre. The pump and motor units are of identical design.

A prototype pump unit of this type has been operated for over 3,000 hours without showing signs of deterioration in performance. A commercial unit capable of powers up to 60 h.p. has been designed for mass production, and a vertical boring mill fitted with this transmission is currently being shown at the Machine Tool Exhibition.

COLD STEEL EXTRUSION

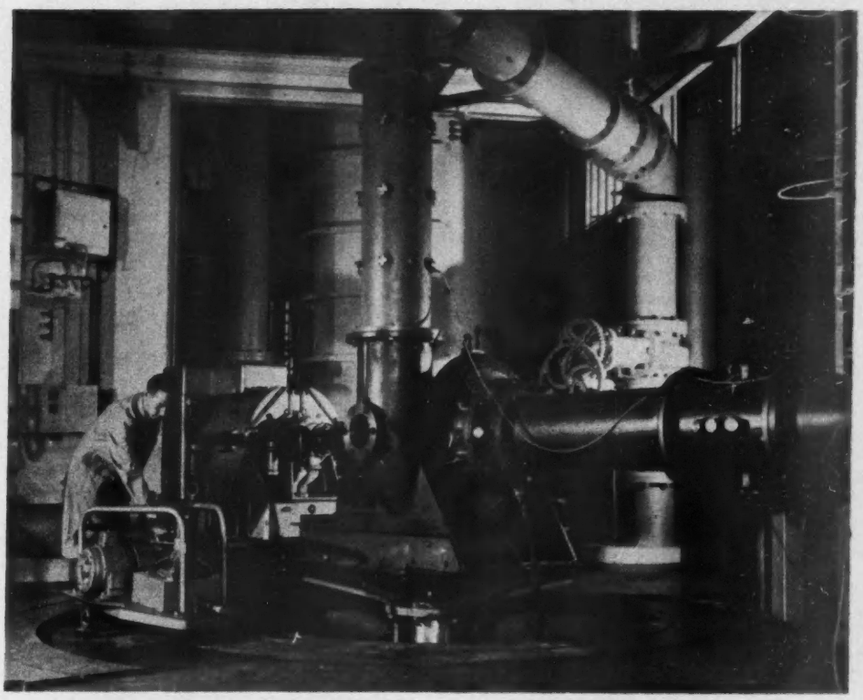
The production of pins, sparking plug bodies, ball race housings and other hollow components by extrusion from an unheated steel billet has the advantages of high production rate, good surface finish and improved mechanical properties as a result of cold working. Machining is also reduced and may even be eliminated on some components, leading to a possible saving of up to 70 per cent in material lost by machining.

Cold extrusion has been used very little in Britain, although the process has been applied extensively in the United States and Germany. One of the reasons for this has been lack of industrial knowhow. Now, NEL are able to offer comprehensive data on the effects of different process variables on the pressure required to extrude various products in a wide range of low carbon and alloy steels. Information is also available on the flow of metal during extrusion, and on the properties of the extruded product.

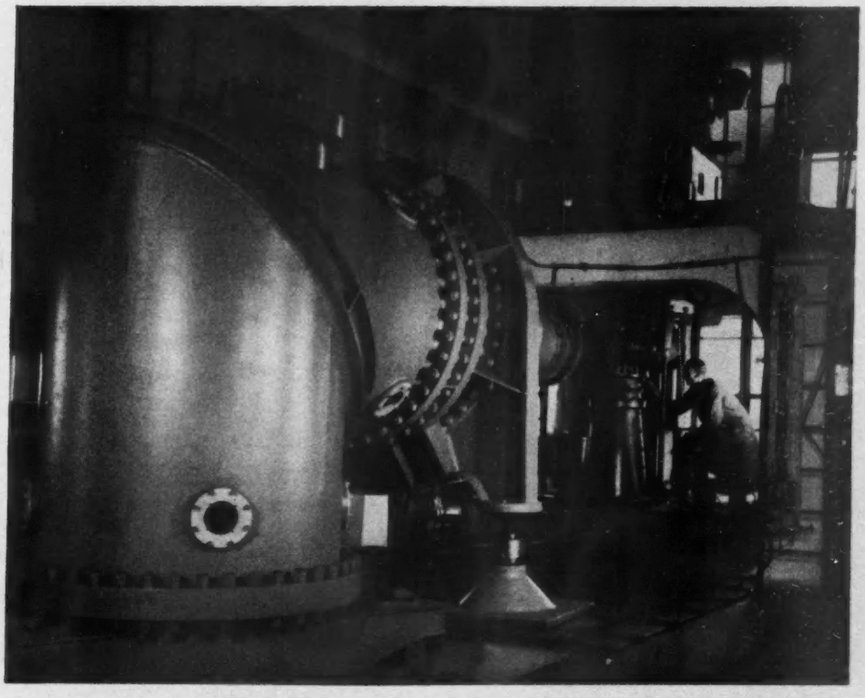
The information available from NEL enables manufacturers to obtain advice on both the extrusion conditions for a particular product and the design of the tooling. Several British firms are now trying out cold extrusion on an industrial scale.

Many of the facilities at NEL are undoubtedly among the best of their kind in the world. However, it still remains for British industrial firms to make more use of the facilities than they are at present. Typical of the opportunities that are not fully appreciated are those available for research and accurate performance tests on pumps and water turbines. These are being used to investigate industrial design problems, some of which are posed by manufacturers of hydraulic machinery. The Laboratory also provides an independent service to consultants and users in order that may make precise tests of efficiency.

The test circuits have been designed so that pump and water turbine models can be tested quickly and accurately under a wide range of operating conditions, with water or air as the working fluid. Digital instruments have been developed to record test data automatically on punched paper tape. From these, the results can be obtained in a matter of minutes by making use of the Laboratory's Deuce computer. Flexibility in the design of the test circuits makes it possible to accommodate industrial models with a wide range of operating conditions. A new circuit has just been completed to test reversible pump-turbines for pumped storage schemes.



A 250 h.p. closed circuit test rig is available for research and test work on centrifugal pumps.



Closed circuit test facilities are being used to assist British manufacturers with the development of water turbines, pumps, oil-hydraulic units and associated machinery.

Unit Built

ATTEMPTS have been made at various times to cheapen the cost of houses by building them from ready made units. The idea is not simply an extension of what was known as the "prefab," where sections came and were erected, with all the troubles of making good, but of bringing complete systems to site.

An example of what has been attempted involved bringing a complete plumbing unit with all the pipes ready to be connected to the various appliances, but few have taken the form of the recent Swedish development in which the entire kitchen and bathroom unit is brought as a single item and mounted direct on the foundations. The idea was introduced by A. B. Allbetong of Malmö and has been reported in the *Anglo-Swedish Review*.

The diagram shows the plan of the unit which measures about 7 ft wide by 14 ft long and weighs about 10 tons. It is primarily suited for bungalows or for blocks of flats. At one end of the unit is an oilfired boiler with its electric control panel; next is the kitchen unit with cooker, and double sink. On the opposite side of the main wall is the bathroom with bath and basin, and in the second section on that side there is the toilet with bidet, basin and closet. All the pipe work and wiring is finished before delivery and the connections for the mains are brought to the outside of the unit.

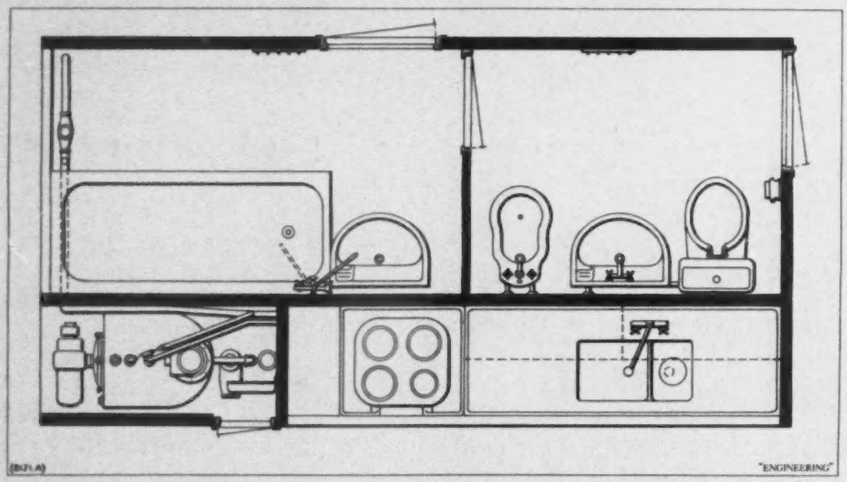
The framework supporting the units is of concrete and so are the partition walls; the frame is probably reinforced and the partitions may be made with lightweight concrete although this is not stated. The two long walls of the bathroom are designed for load bearing, and the four doors are ready hung. An obvious advantage is the simplicity of the connections to mains services, which should reduce both installation costs and maintenance. Provision can be made to include arrangements for floor heating.

The method of erection that has been employed by the makers in Sweden is to bring the units—they have named them "Hearts"—on lorries and trailers, encased in some form of weather proofing. When several have been assembled on the site, a mobile crane is brought up and it lifts them one by one on to their foundations. The installation rate has been from six to eight units a day. The foundations used can be either walls or four separate plinths, so allowing considerable variation in the layout of the house. Providing that the building of the house has not advanced so far as to impede the crane, the Hearts can be put in position at any stage. It is, however, desirable that once in place they should be roofed over reasonably quickly.

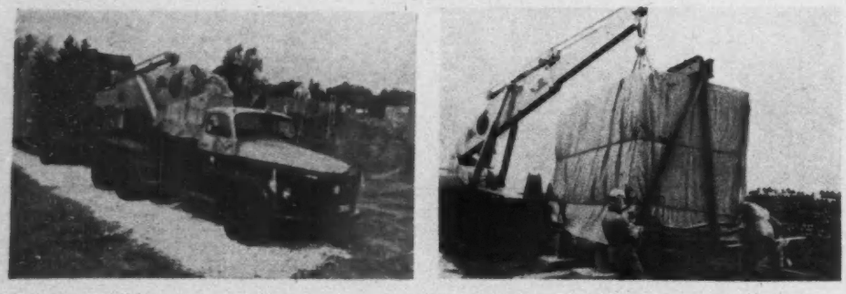
It is claimed that installation of these units leaves the architect almost entirely free as far as general lines of the house are concerned, and that the one part which is fixed is designed on sufficiently generous lines to compare favourably for roominess with other modern standards of comfort and usage.

Four types of the Heart units are now in series production, the total rate being about 65 a week. These standard types are for installing in bungalows. A variation in the water pipe connections allows a second bathroom to be built on the upper floor, and no doubt further modifications to the basic plan could produce bathroom and kitchen sections one above the other. This would of course greatly expand the market. The makers have already designed another bathroom unit (to be known as the "Kidney") specially for blocks of flats and it seems probable that it could be combined with a modified "Heart" to complete the installation.

Although in these Swedish units the framework is made of concrete, it would seem possible to use other materials; perhaps a steel or light alloy frame, filled with laminated decorative panelling, and the timber industry could offer a wooden alternative that would be hard to beat.



Layout of a "Heart" unit for a bungalow, showing kitchen, bathroom and toilet.



The units are brought by lorry and set up by crane direct on the foundations.

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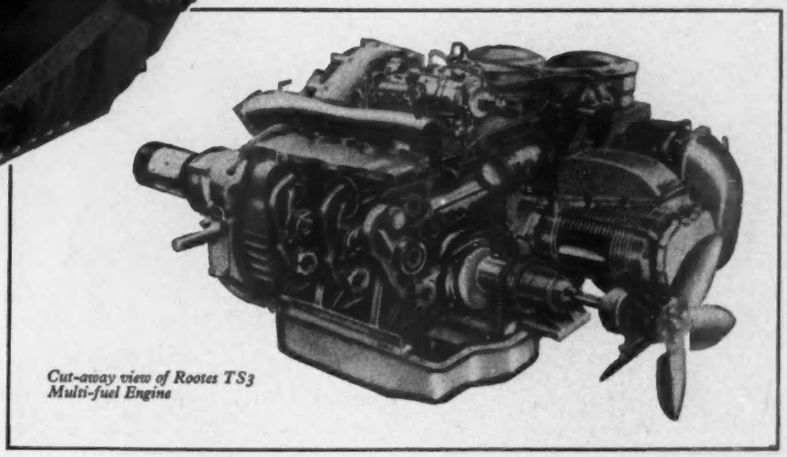

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1½ in. dia.	Oil quenched 850°C tempered 560°C	68	73	19	55
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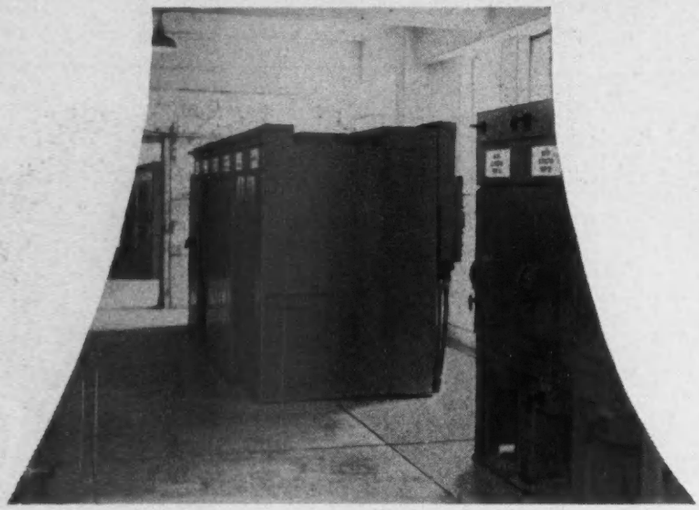

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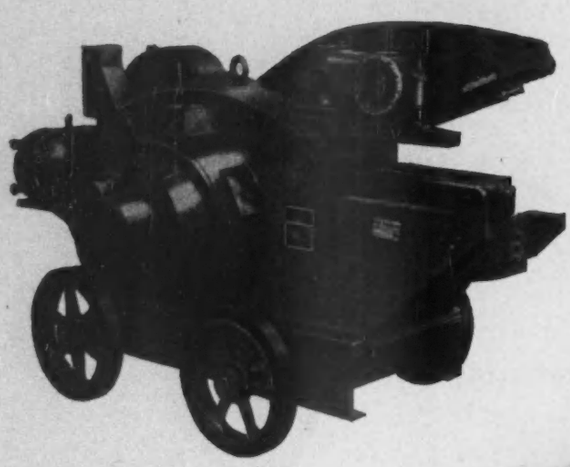

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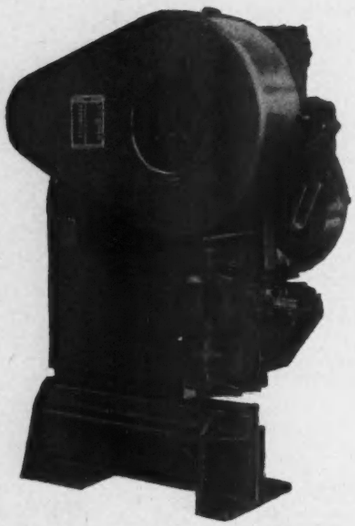

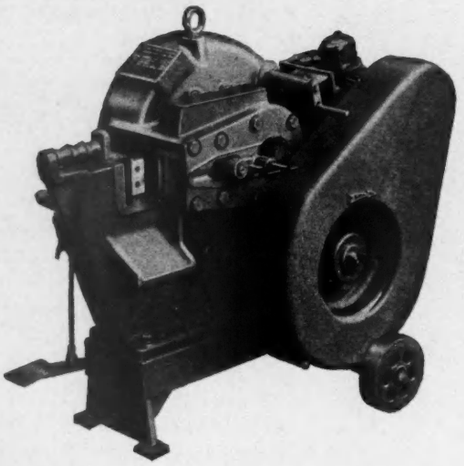

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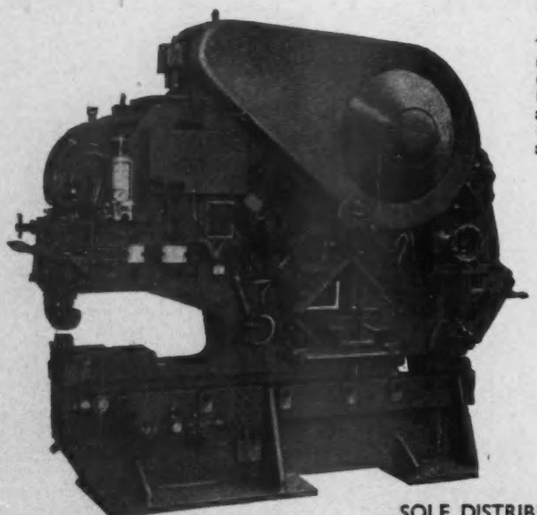

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March 1960

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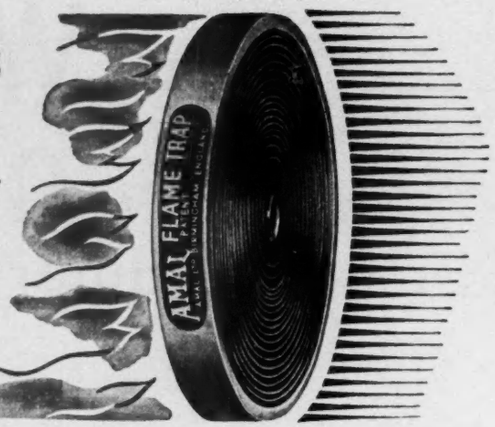

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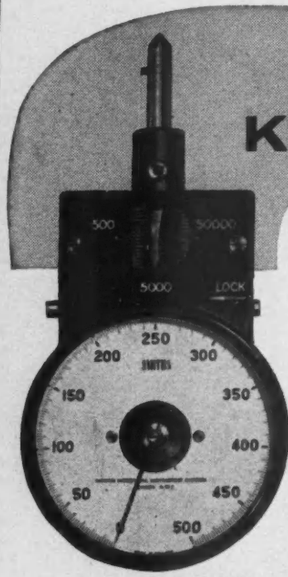

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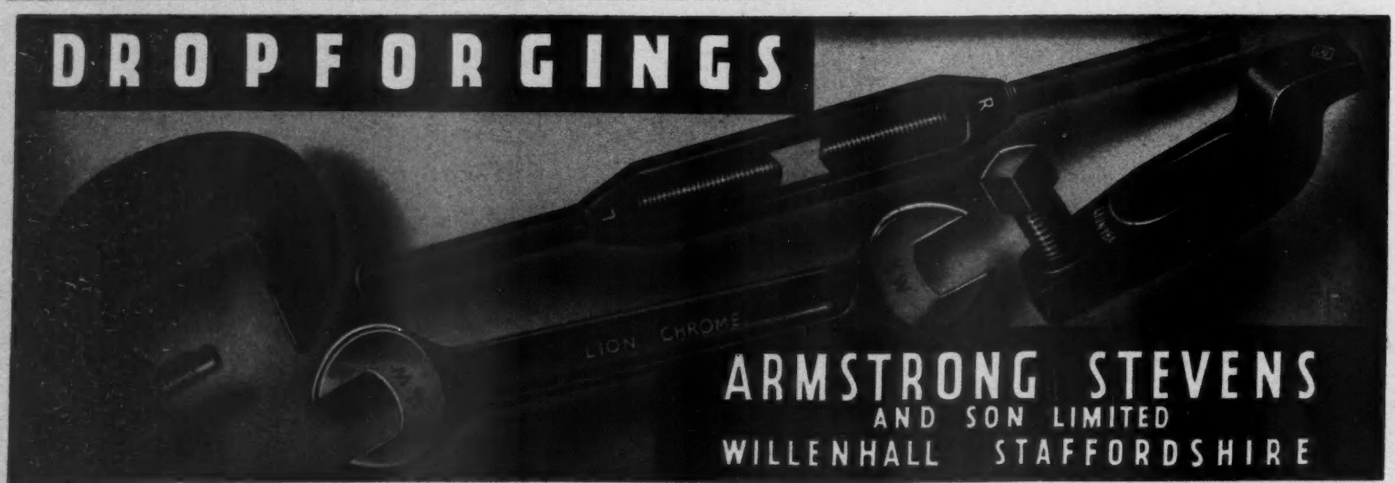

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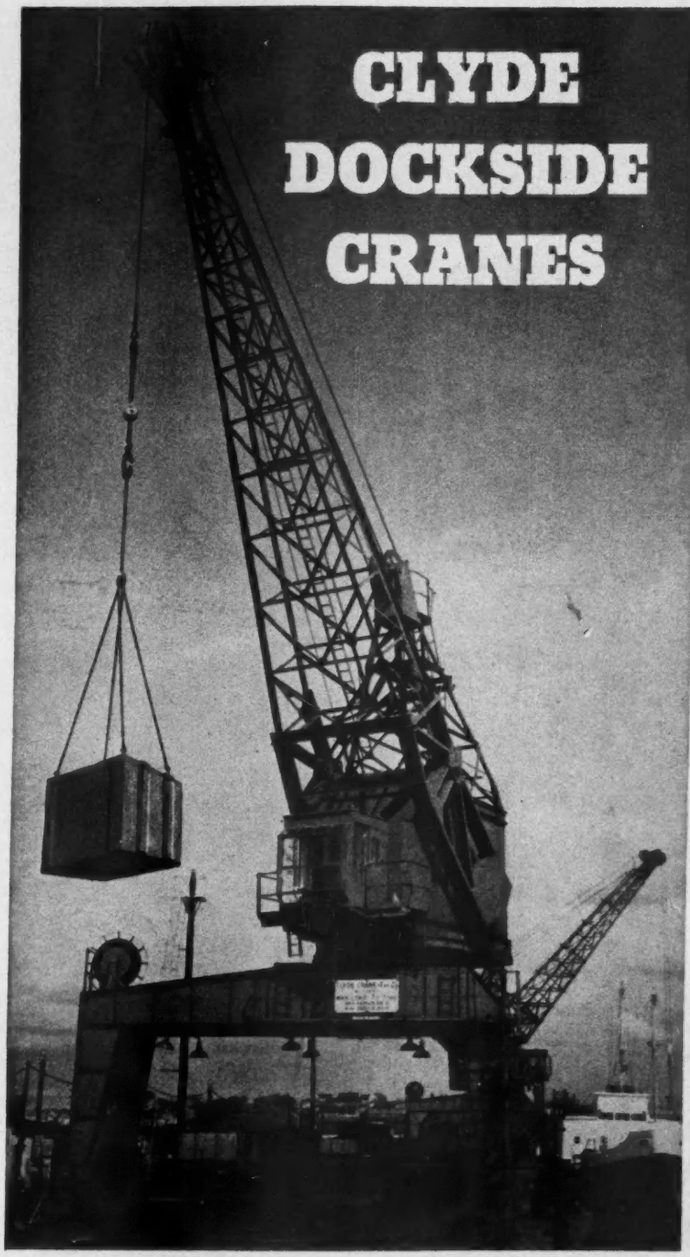

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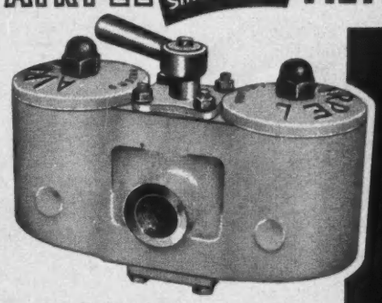

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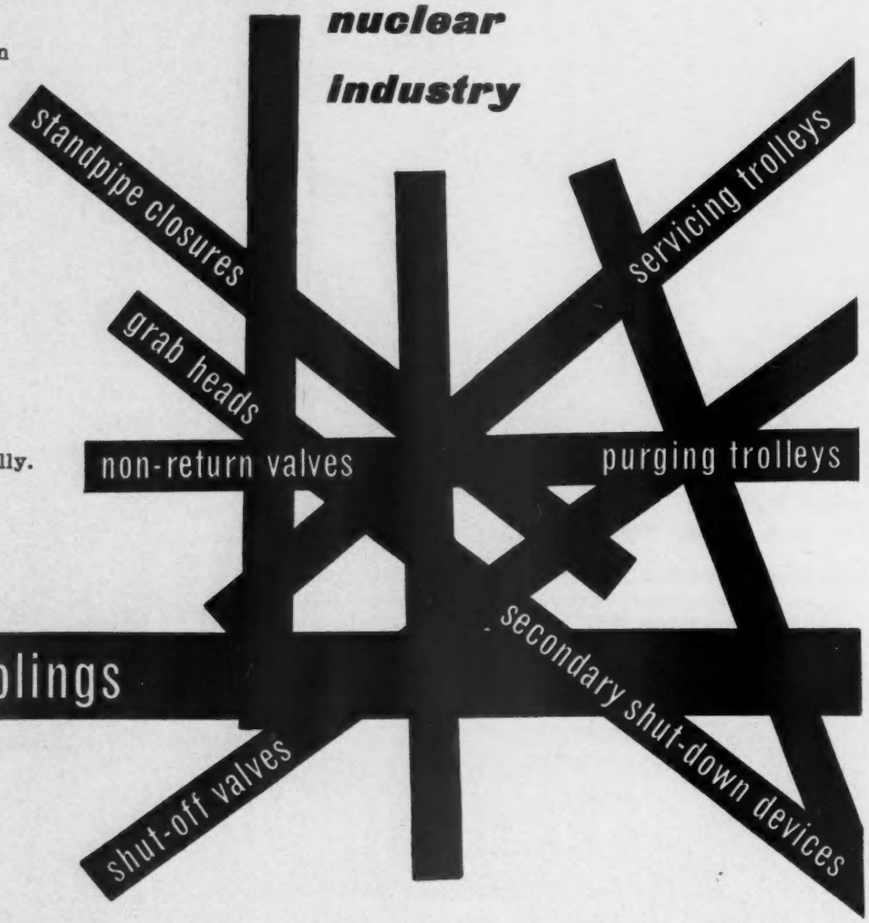

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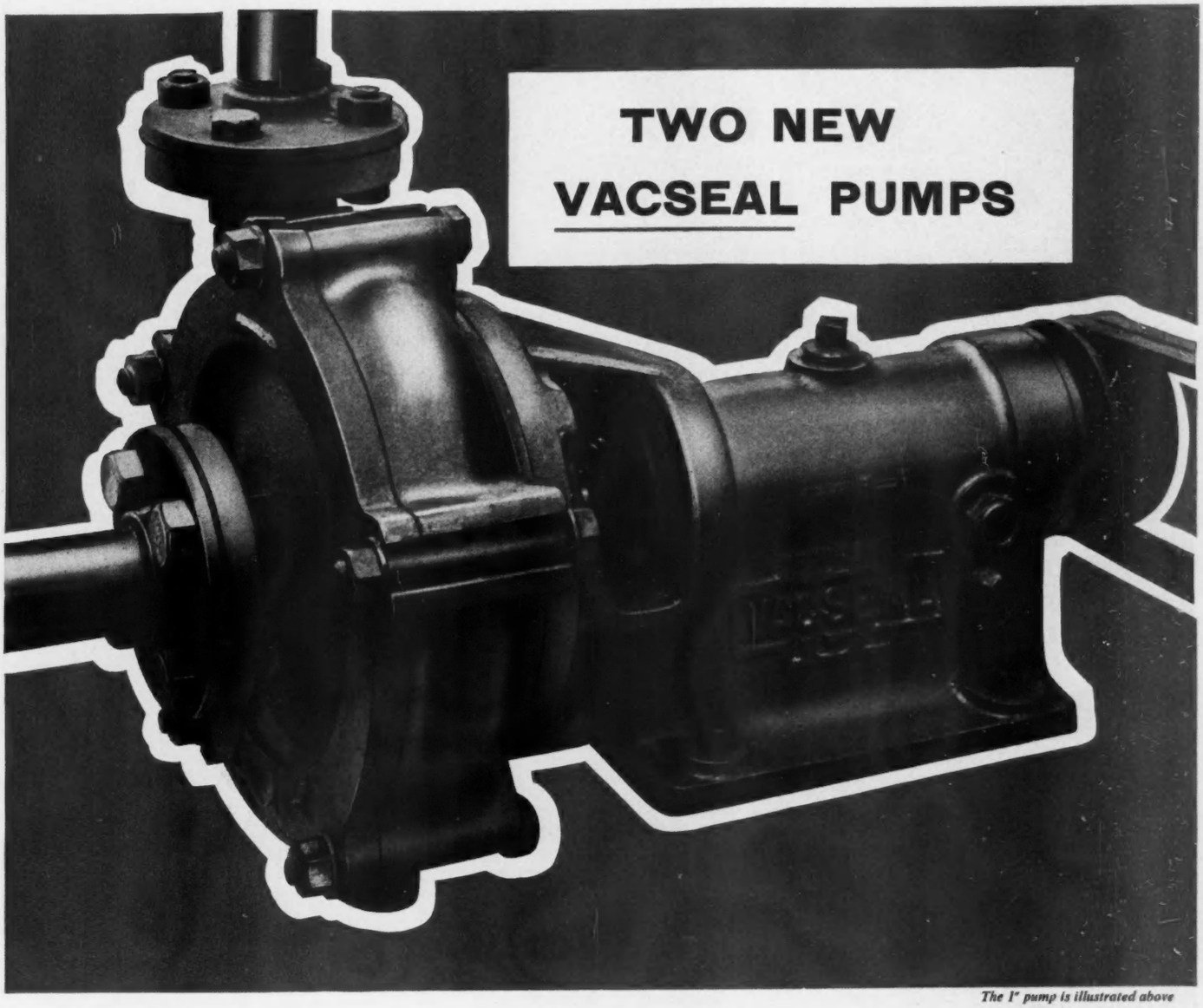

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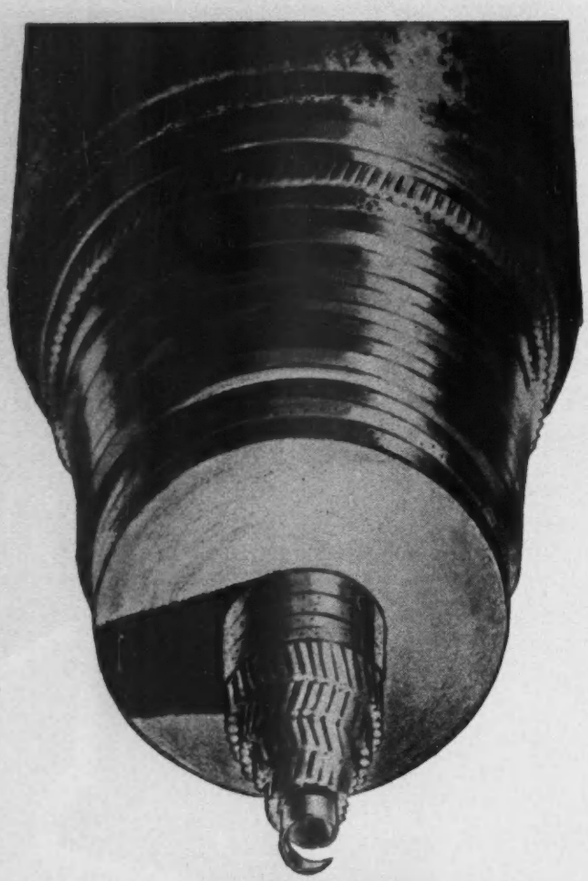

Ascending a 540 foot vertical shaft in the rock, twelve single-core 330,000 volt oil-filled cables link the Kariba power station with the transmission lines above.

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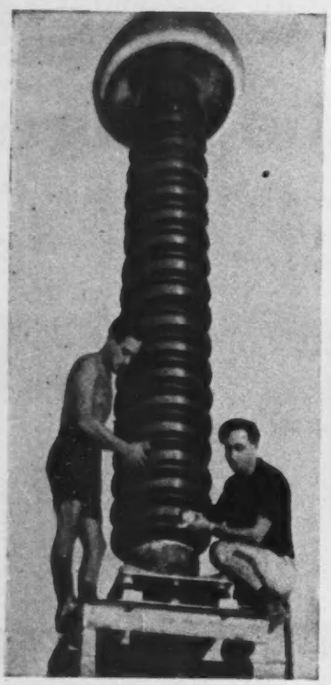
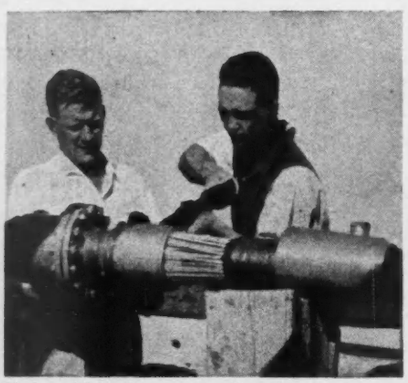
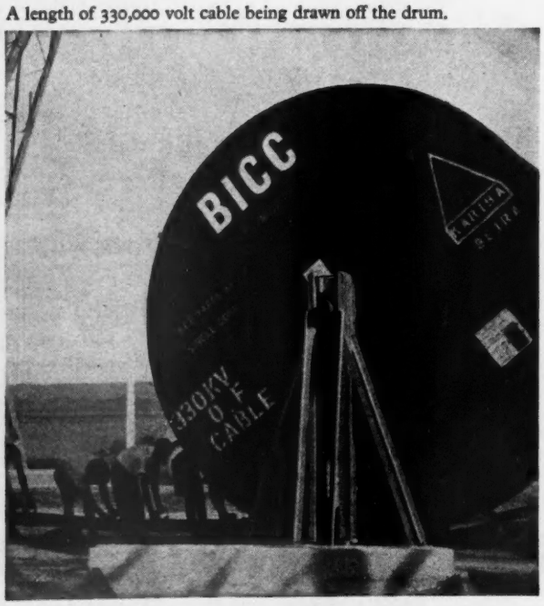


Installing a 330,000 volt cable termination.
(*Copyright : Federal Power Board*)



Fitting a high oil-pressure cable-end cap.

A length of 330,000 volt cable being drawn off the drum.



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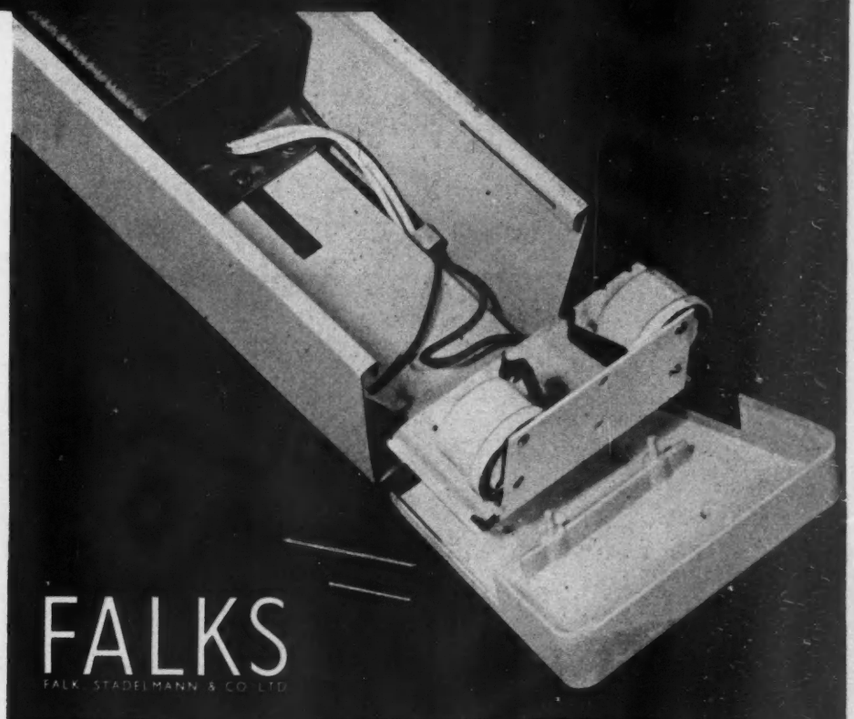

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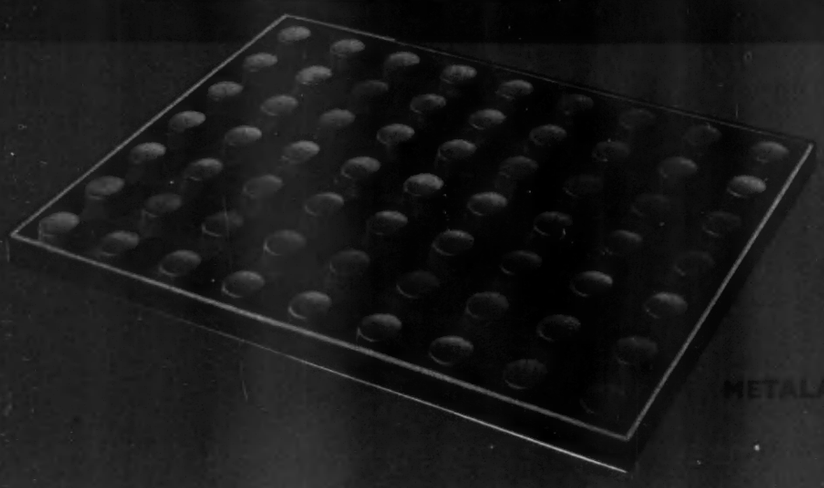

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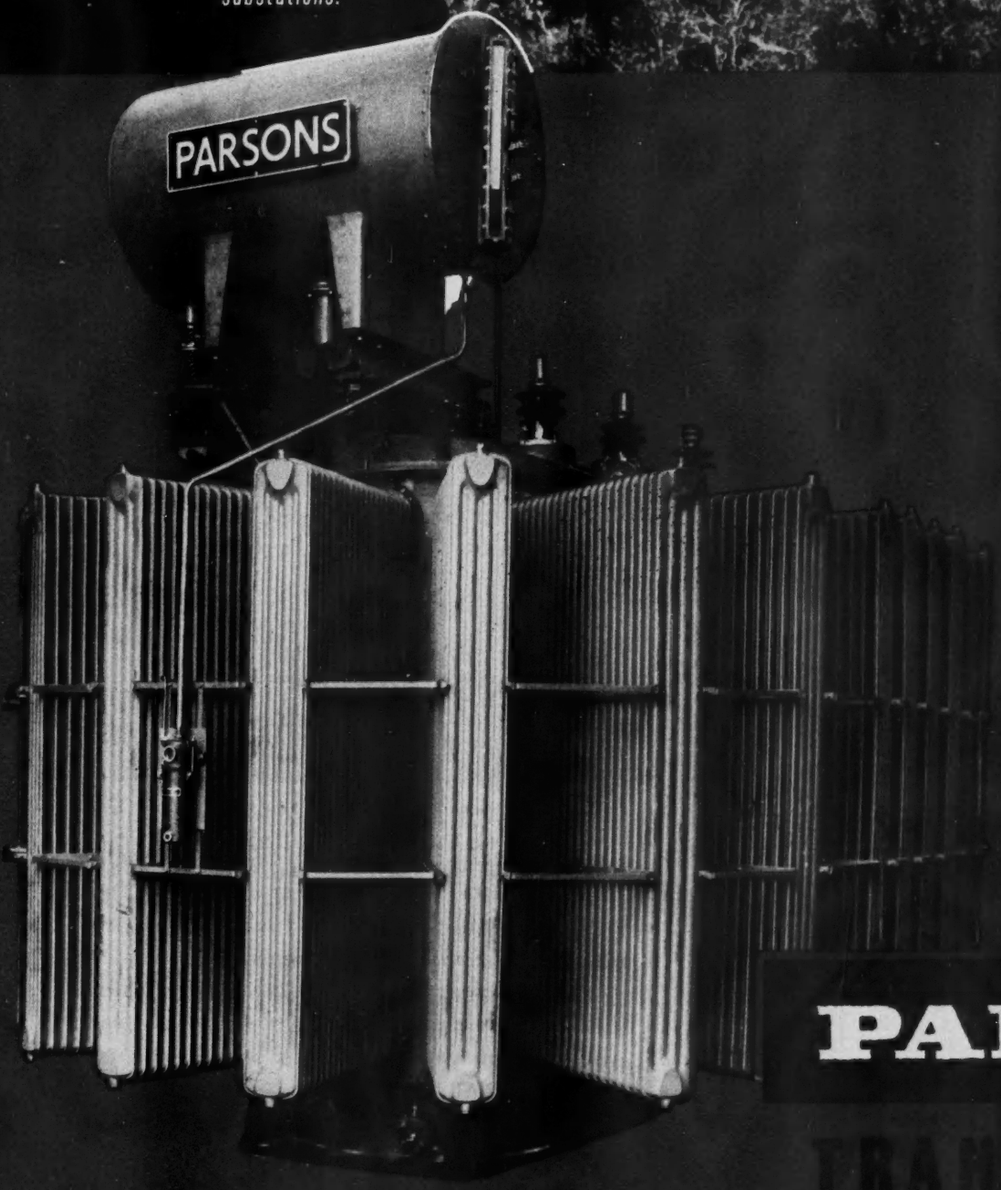

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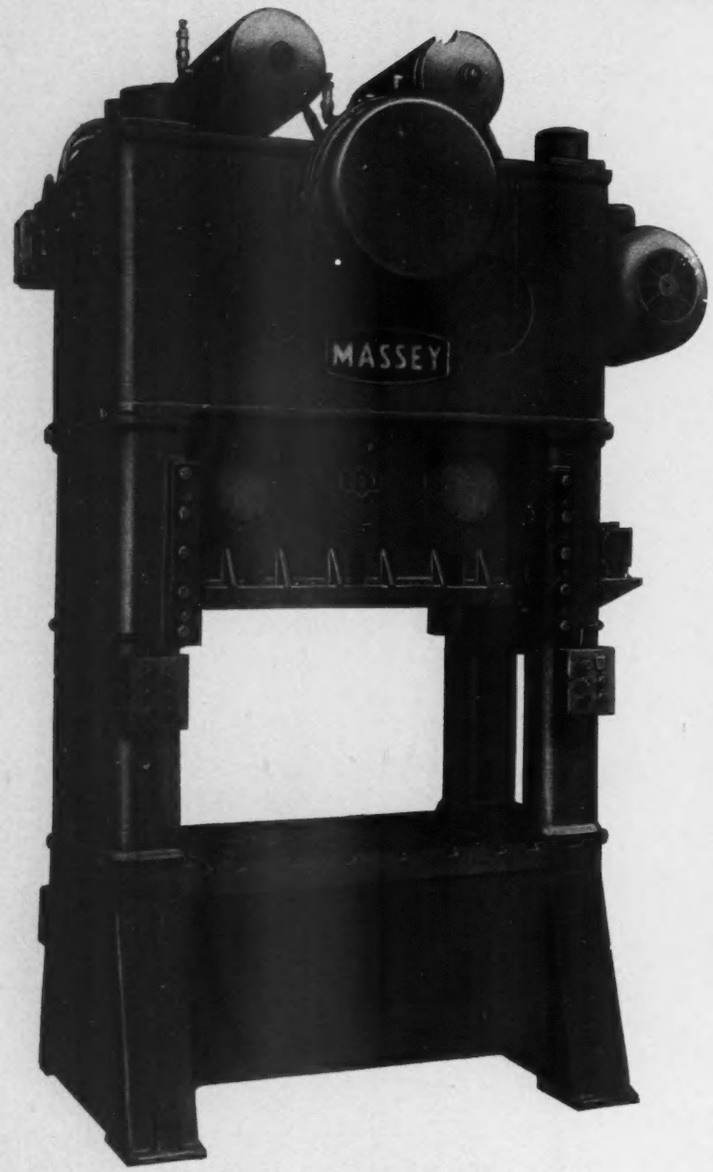

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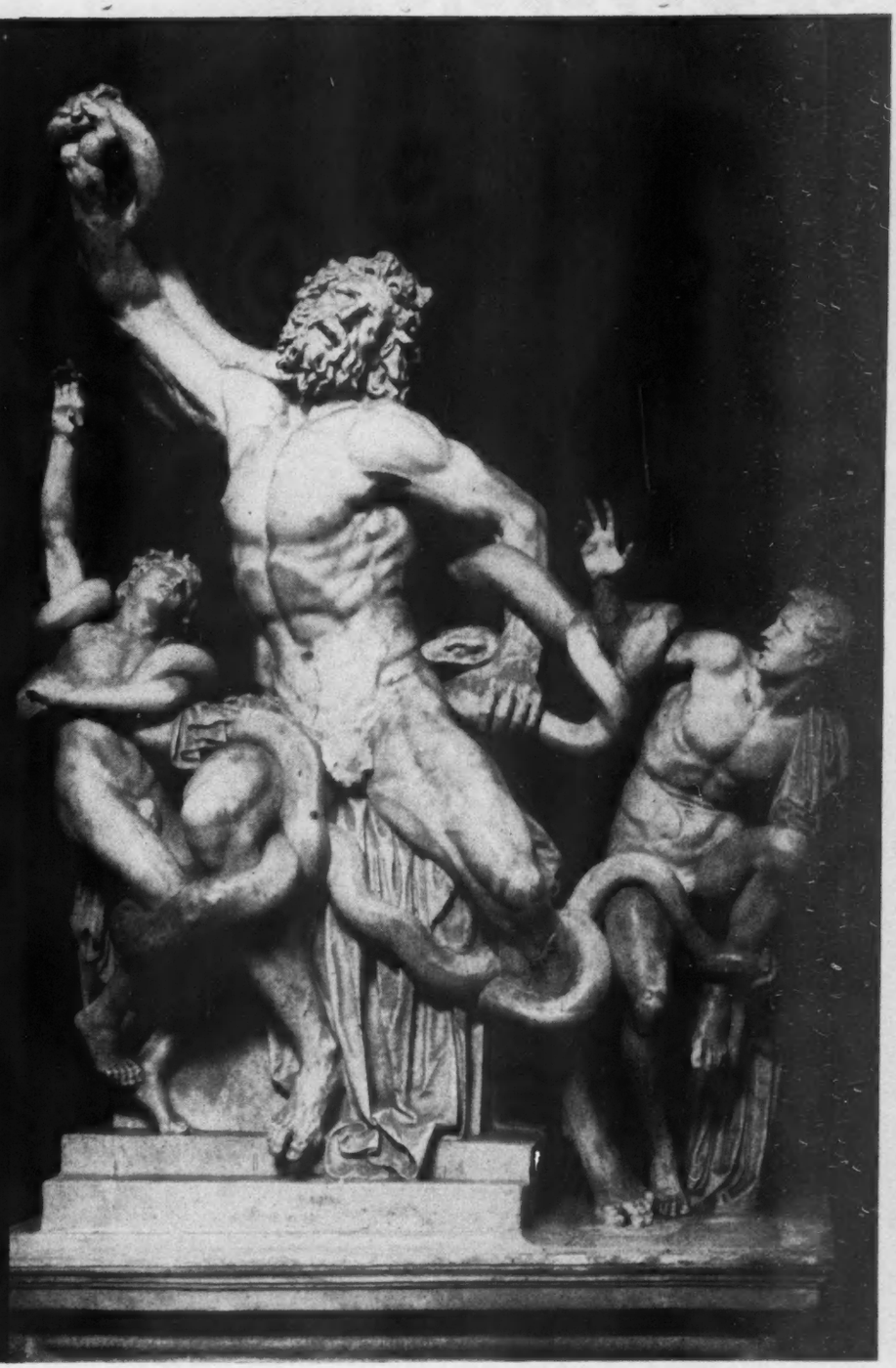

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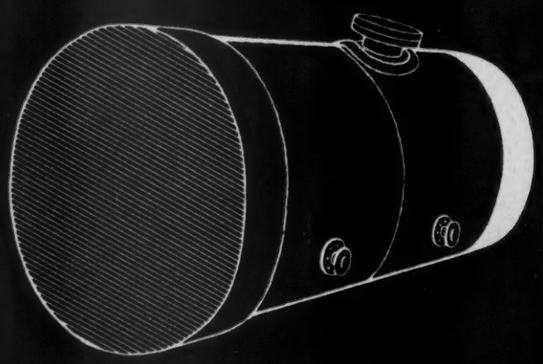

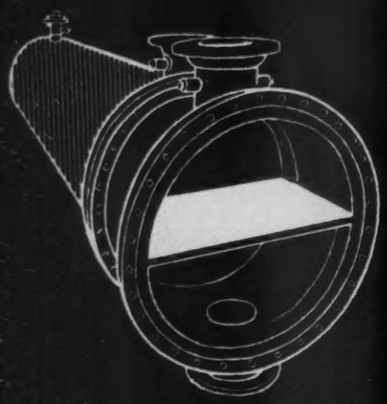

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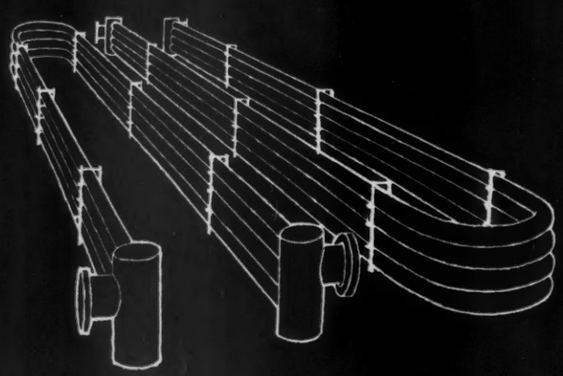

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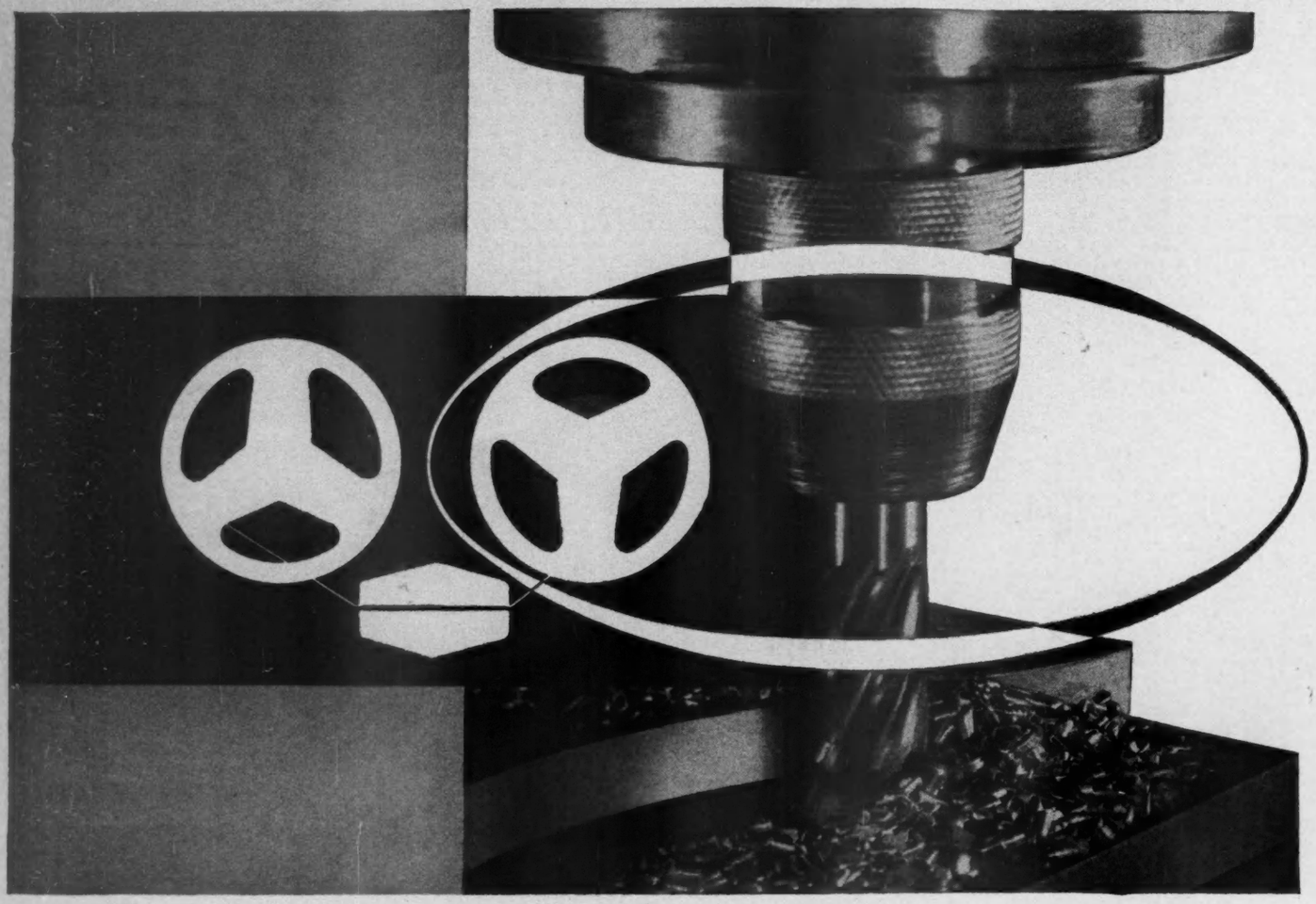

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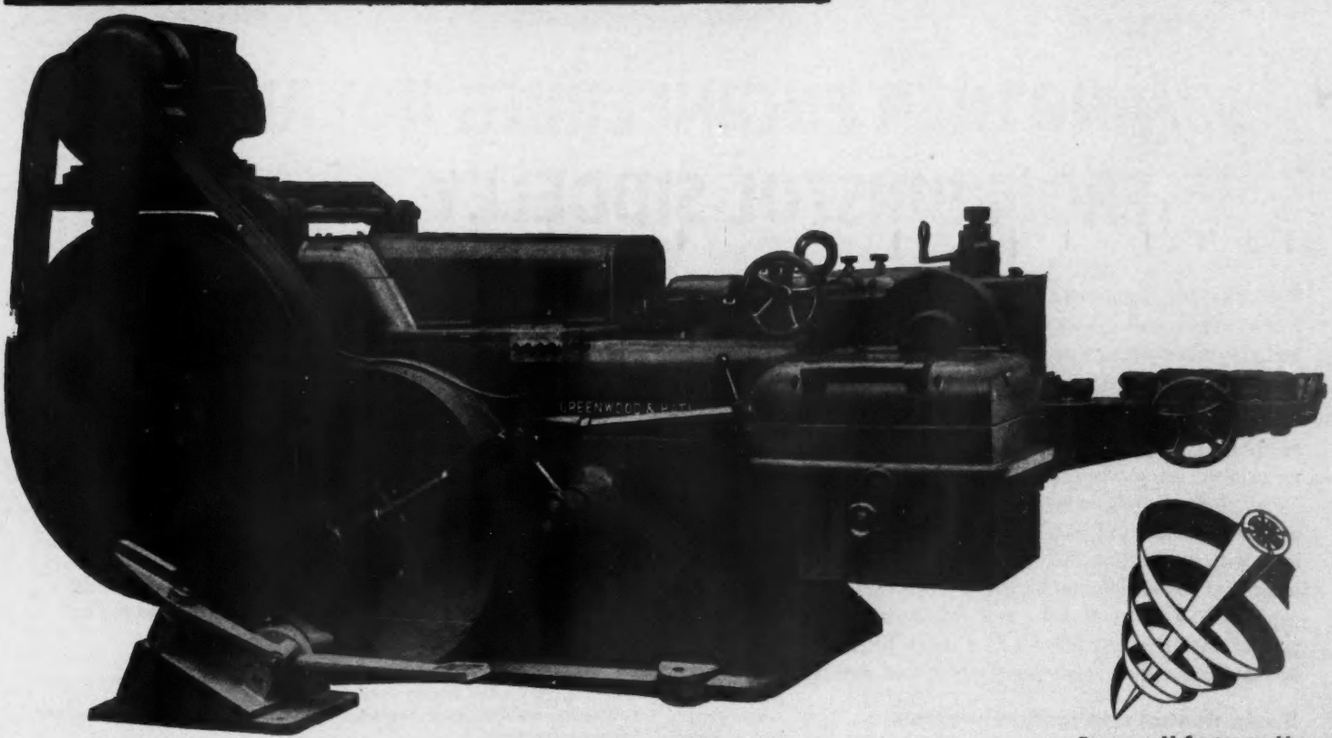

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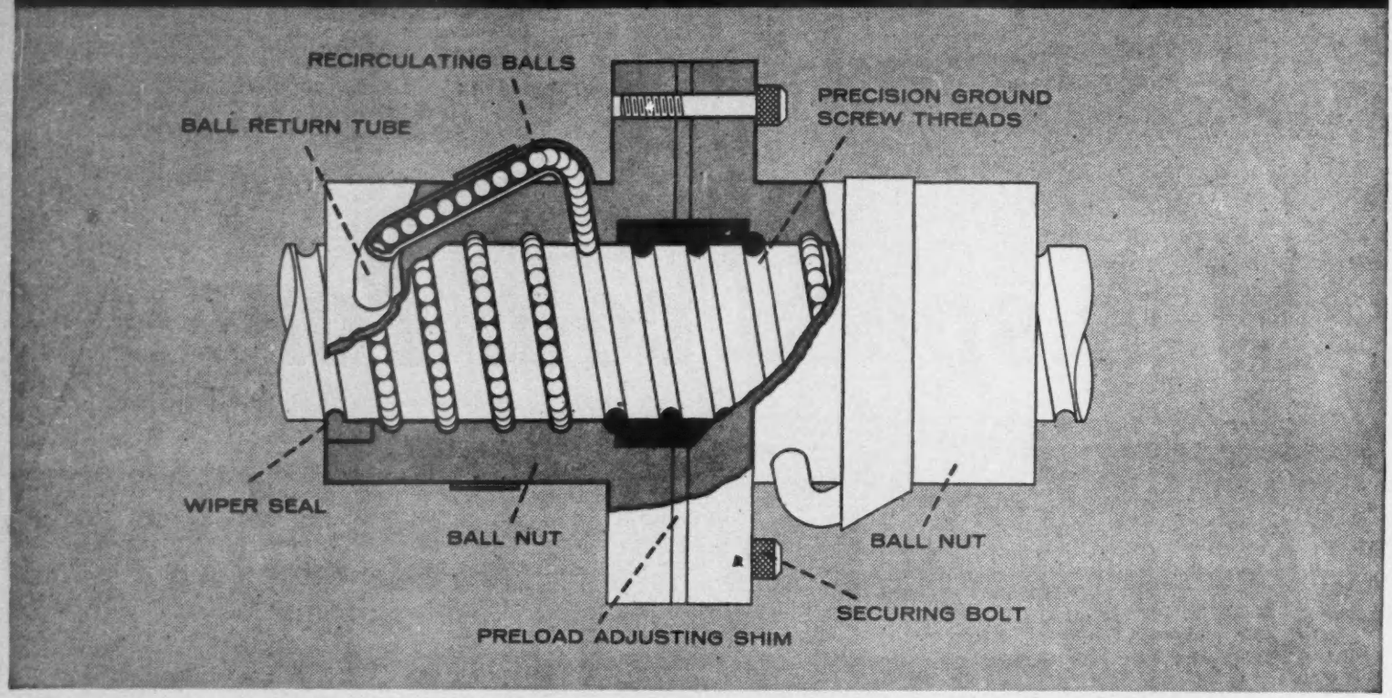

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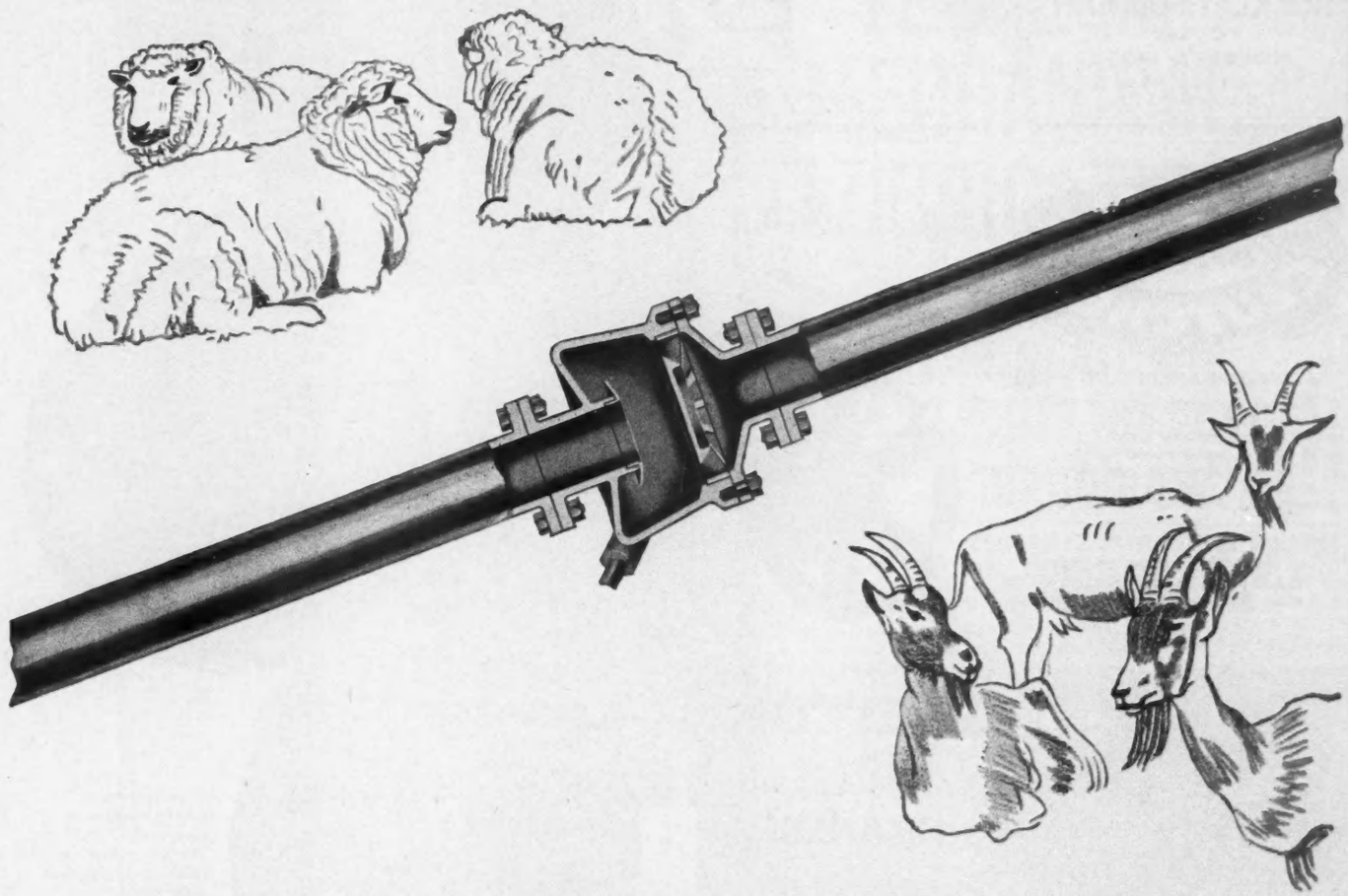

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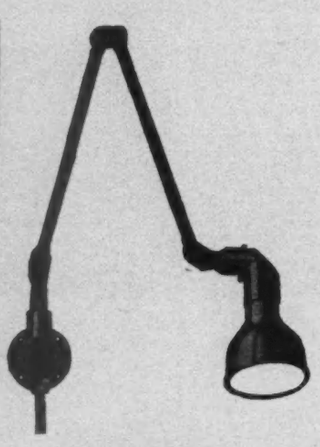

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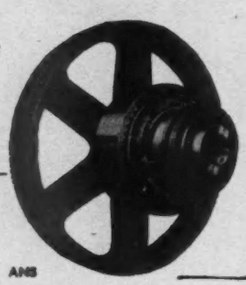

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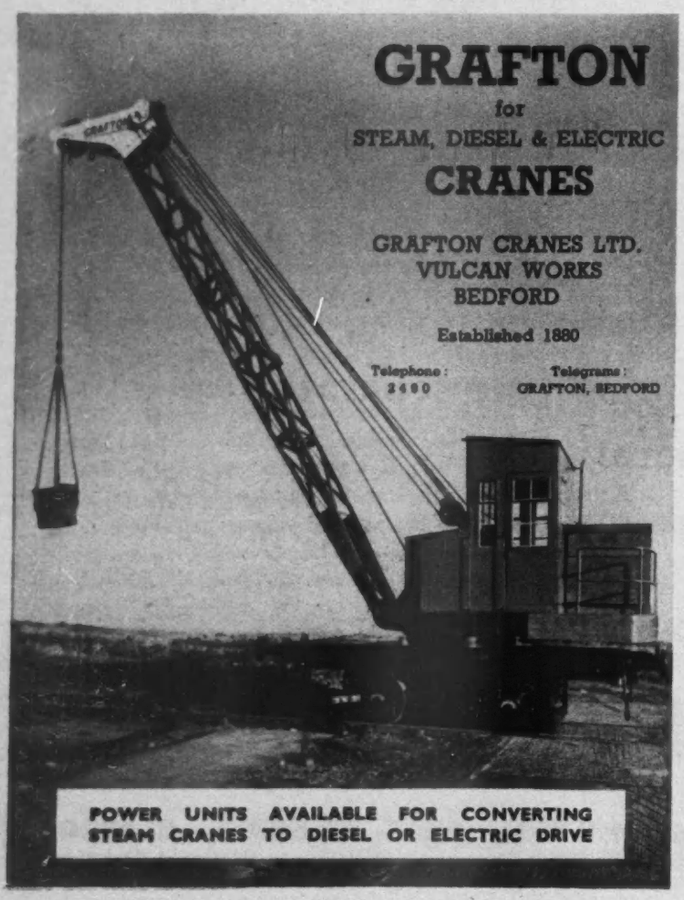

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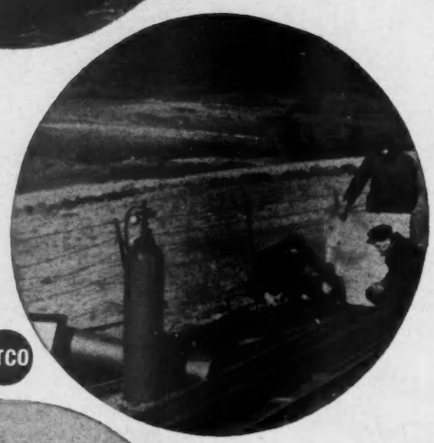

Oxy-acetylene rail re-surfacing on Snowdon's Mountain Railway.
(With acknowledgements to British Oxygen Gases Ltd.)

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50 lbs. lightweight cylinder mounted on Kidde Model T.50. Fire Extinguisher Truck Unit
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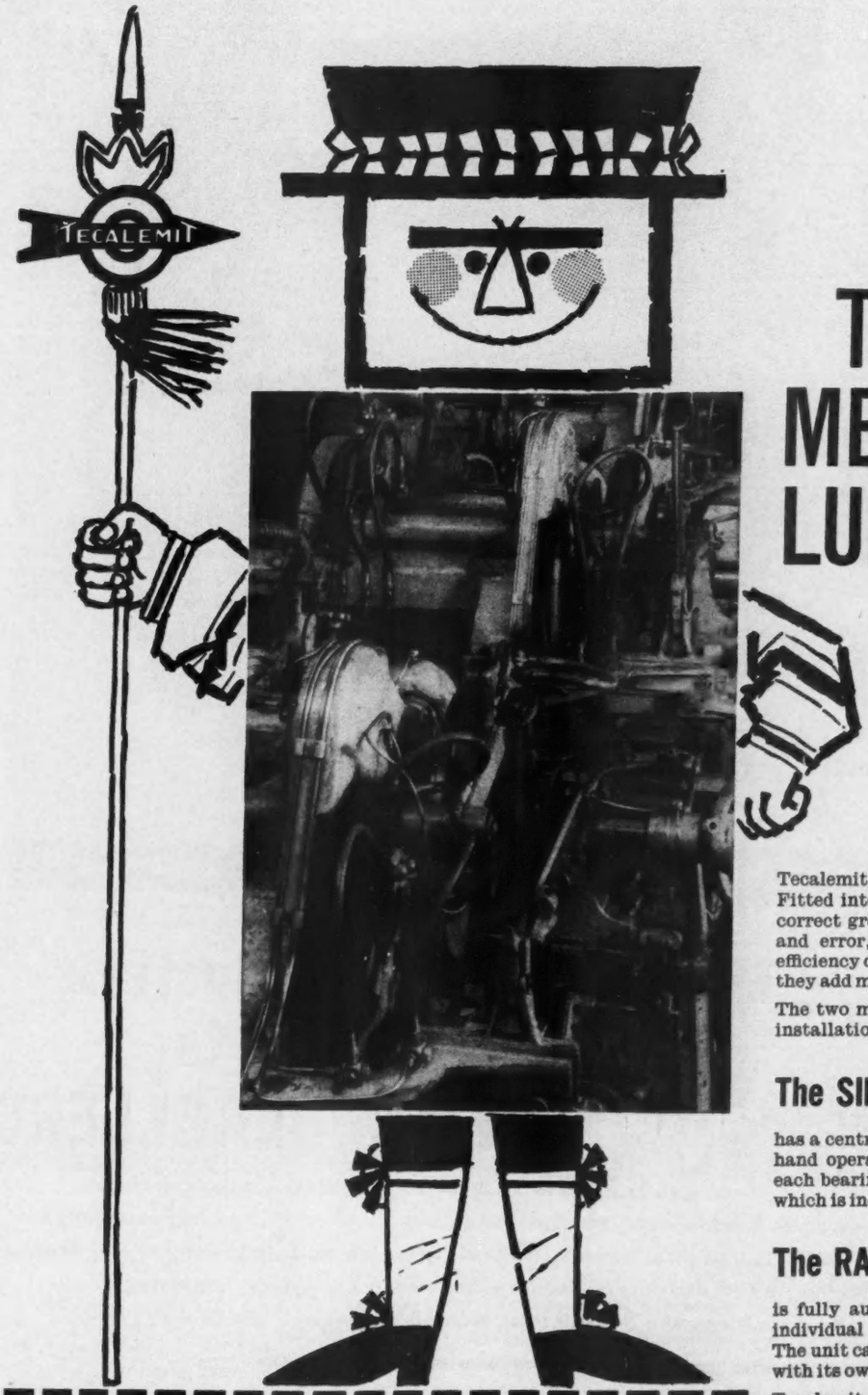

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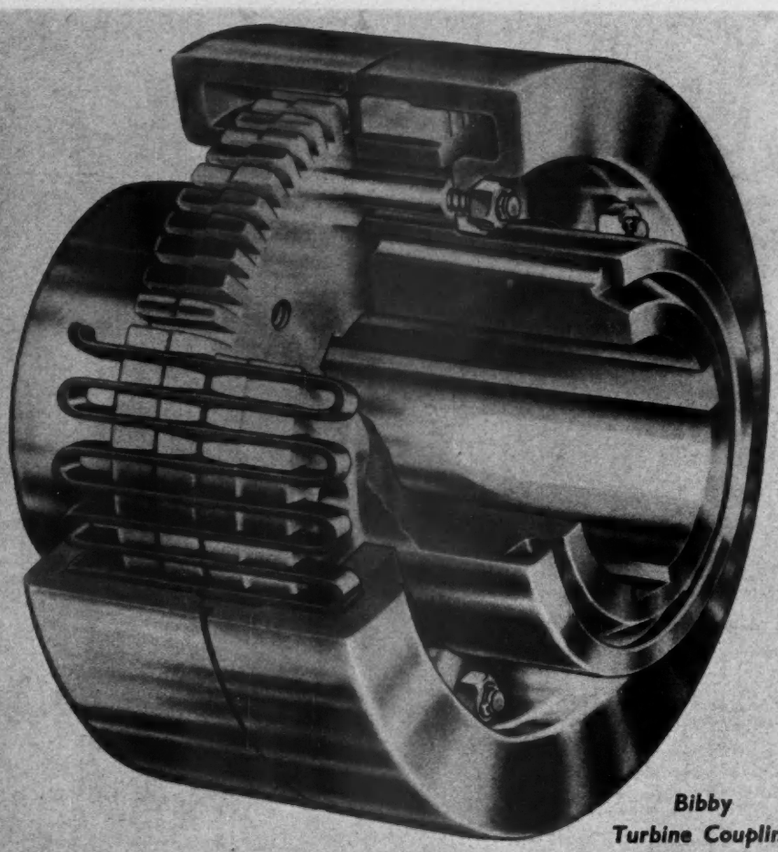

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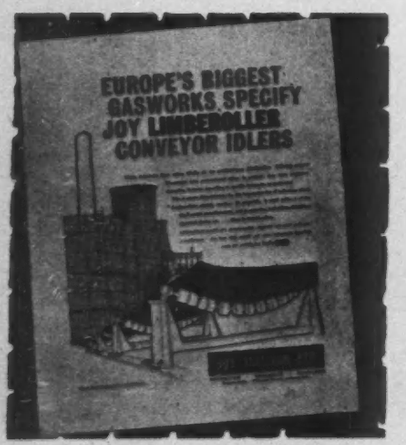

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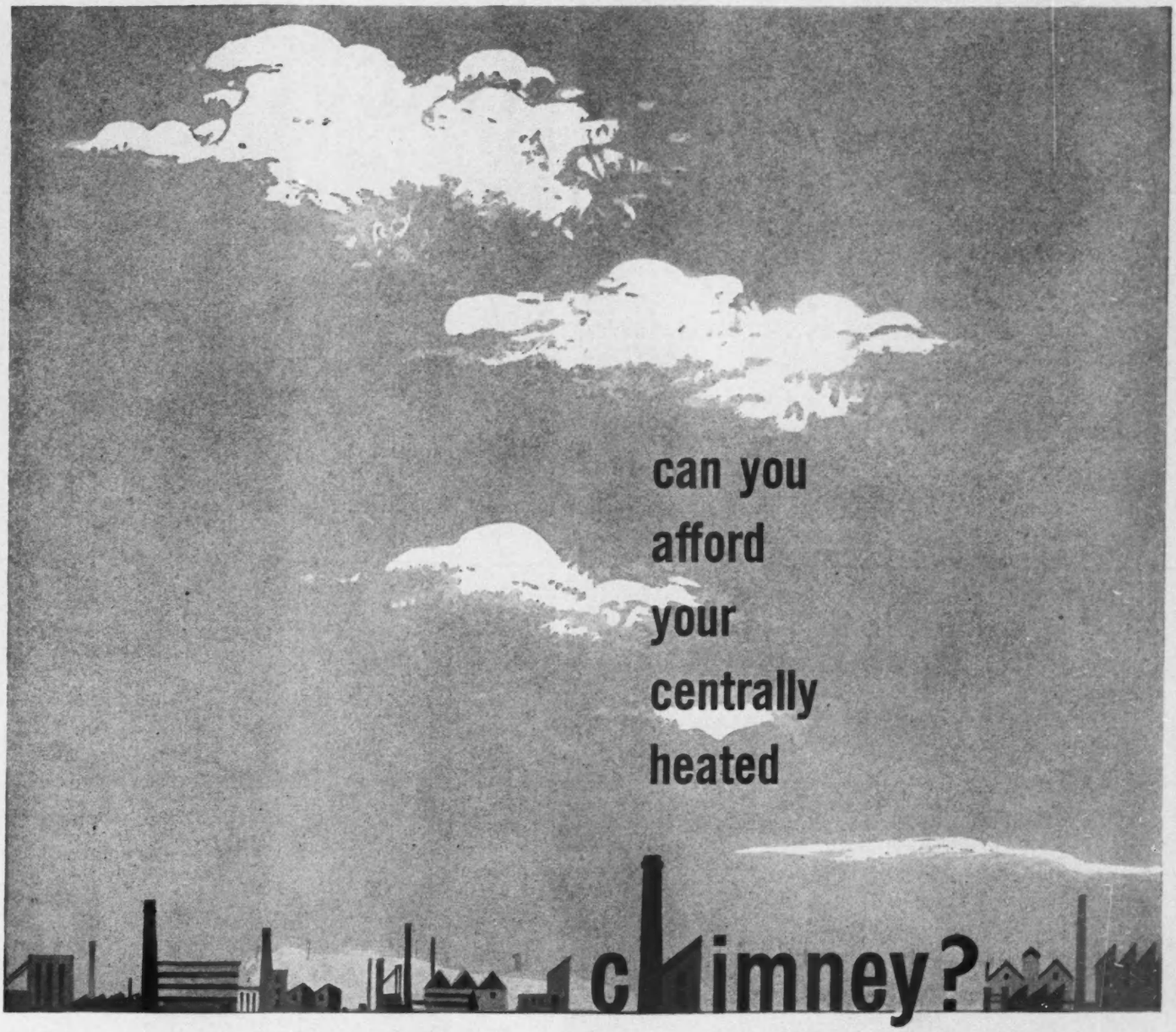

With rising production costs it's hardly likely. The people to see are Spencer-Bonecourt-Clarkson who for over forty years have been experts in waste heat recovery for steam raising in a wide range of industries. In addition to fire-tube boilers, *S-B-C now also supply water-tube boilers.*
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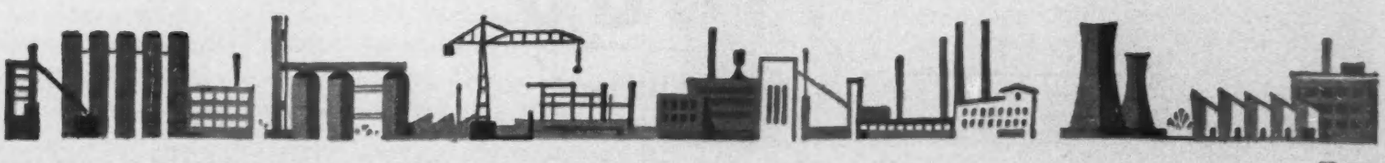

SBC

. . . and VISCO air filters

Today many successful Engineers are making a standard practice of including VISCO Air Filters in their specifications. VISCO make a variety of Air Filters to cover every requirement. For inexpensive installation costs, easy maintenance, reliability and endurance make sure that you specify VISCO equipment. Full details from VISCO ENGINEERING CO. LTD., Stafford Road, CROYDON, Surrey. CROydon 4181.

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The 'K.M.' Type is an oil-wetted Air Filter. 98% efficient by gravimetric test, lighter and easily cleaned. Any number of units can be bolted together to form an installation.

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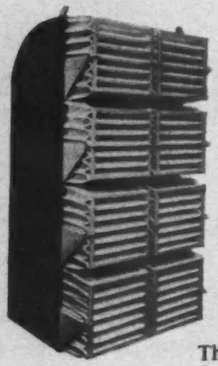

The 'M.V.' dry type is over 98% efficient. Each unit will deal with up to 1,000 c.f.m. Throw-away filter elements are easily changed after several hundred hours.

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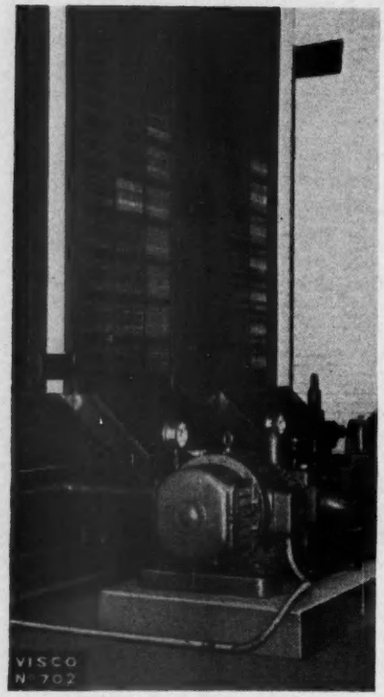

'Reciprojet' automatic self-cleaning type capable of handling heavy dust loads for long periods. Specially satisfactory for ventilating equipment supplying air to electrical machinery in industry.

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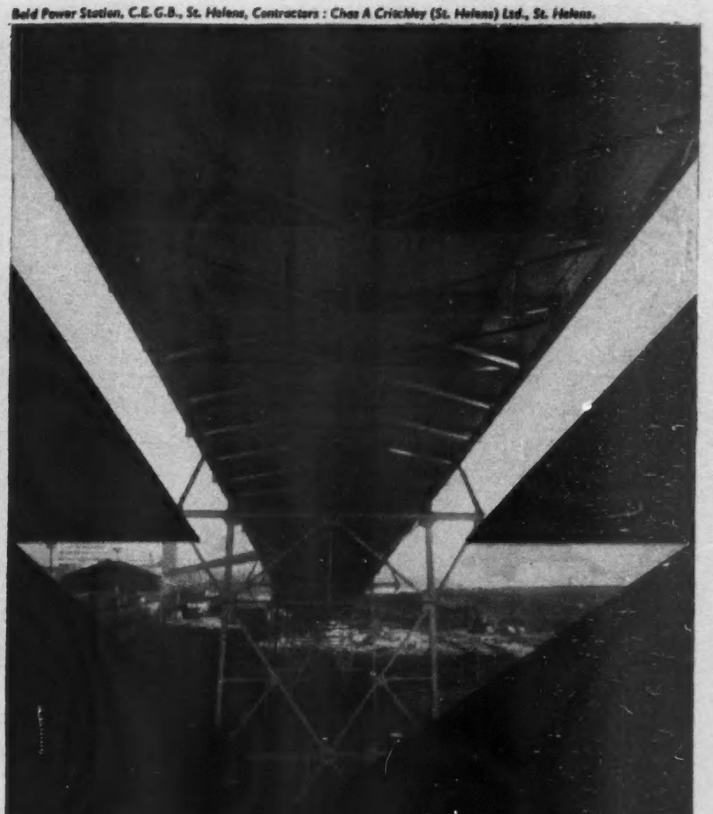
Bold Power Station, C.E.G.B., St. Helens, Contractors: Chas A Crichley (St. Helens) Ltd., St. Helens.



Prevent CORROSION

Zinc Chromate Primer and Epilux 1 — two outstanding anti-corrosive coatings already widely used throughout industry — protect steelwork at Bold Power Station.

ZINC CHROMATE PRIMER: A water-resisting medium, ensures maximum defence against corrosion on non-ferrous metals. Cheaper than red lead, it spreads further and more easily, dries faster and harder, good storage life, easy to mix. In yellow, green and red.

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EPILUX 1

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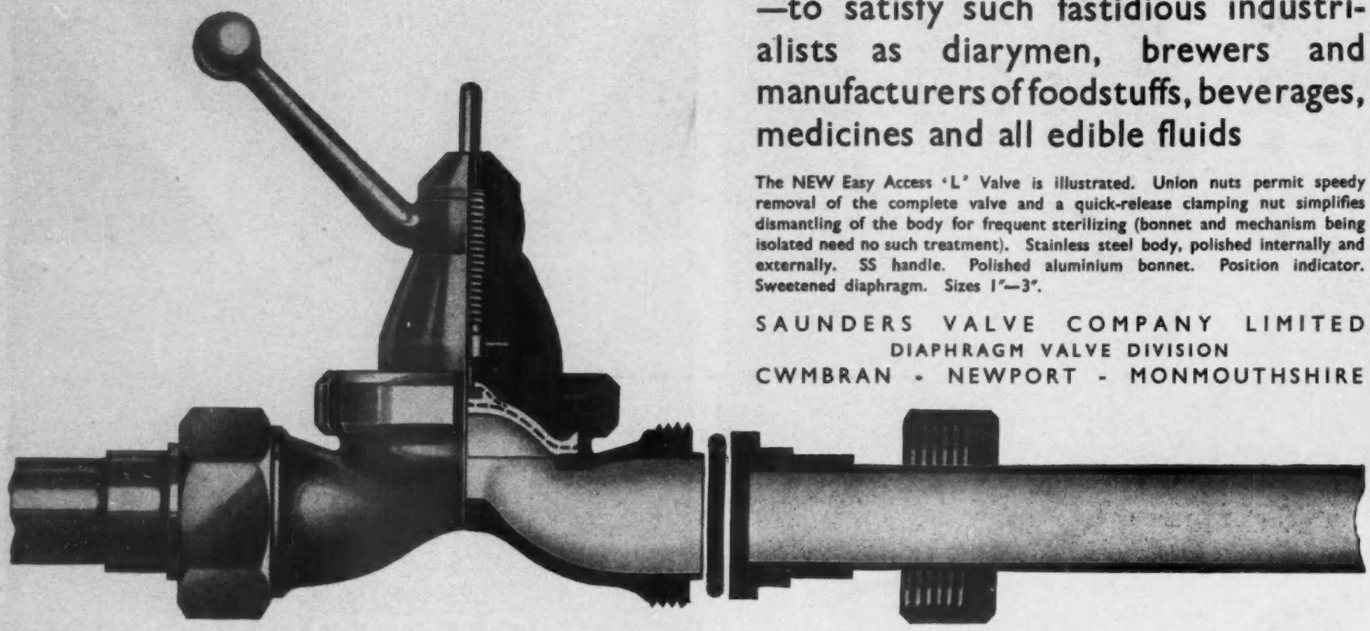

The NEW Easy Access 'L' Valve is illustrated. Union nuts permit speedy removal of the complete valve and a quick-release clamping nut simplifies dismantling of the body for frequent sterilizing (bonnet and mechanism being isolated need no such treatment). Stainless steel body, polished internally and externally. SS handle. Polished aluminium bonnet. Position indicator. Sweetened diaphragm. Sizes 1"—3".

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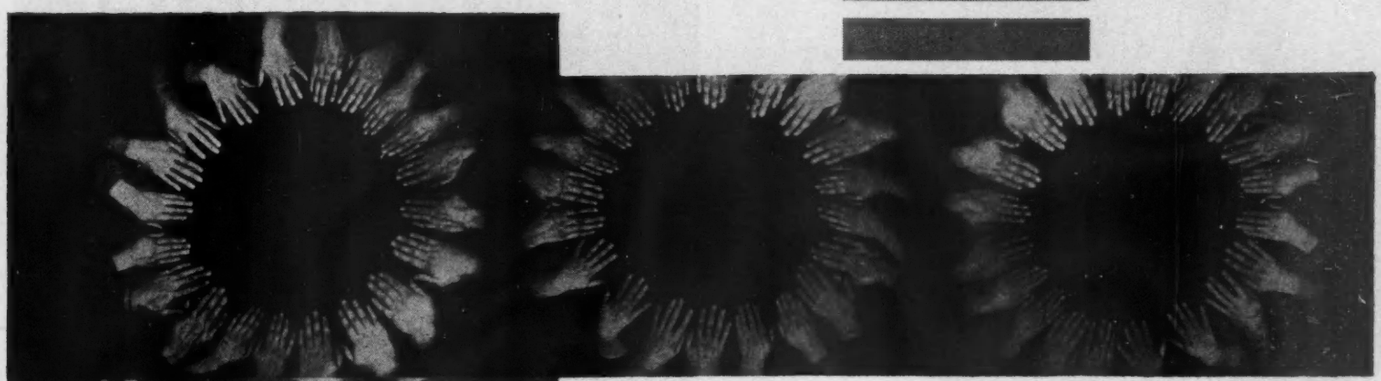

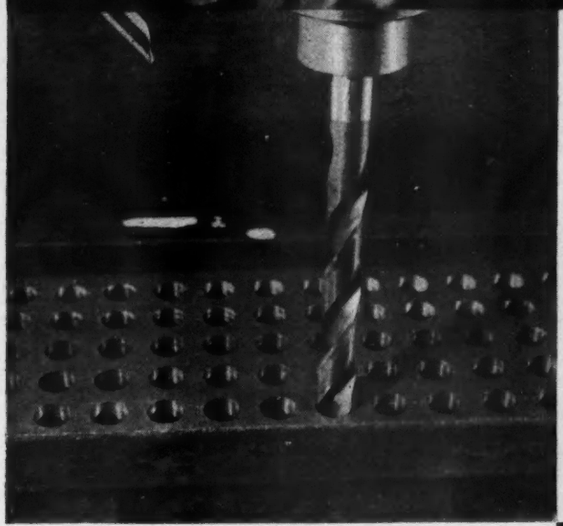

PRODUCTION It takes at least thirty people—thirty pairs of skilled hands—to make one DORMER Drill. Every operation is performed by experienced operators with the most up-to-date machinery. Careful heat treatment and inspection are equally essential in maintaining the consistently high standard of DORMER Tools.

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PERFORMANCE

With correct use, a DORMER Drill of 1" diameter, in its lifetime on general purpose work, will remove 2,800 times its own weight in material (over 1¾ tons), and drill a total length of hole five hundred yards long.

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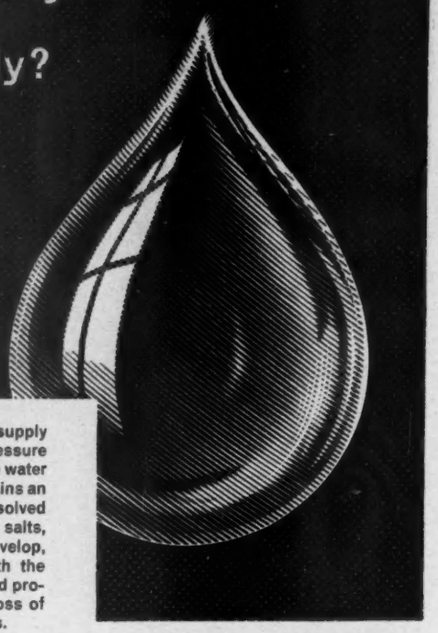
Did you know that this

drop of water

could sink you financially?



A boiler is designed to supply pure steam at a given pressure and temperature. But if the water used for the purpose contains an excessive amount of undissolved solids, harmful gases or salts, serious trouble may develop, and everything be up with the boiler. The results—delayed production, extra costs and loss of profits could be disastrous.

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Vulcan are specialists

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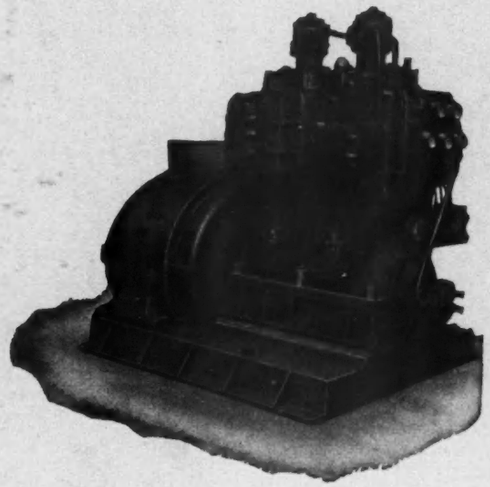
AIR COMPRESSORS for DIESEL SHIPS



This shows our latest 3-stage Vertical Enclosed Marine Type Diesel Auxiliary Compressor, with Forced Lubrication, direct coupled to an Electric Motor. Machines may also be arranged for Steam Driving, and have either one or two cranks, depending on the output.

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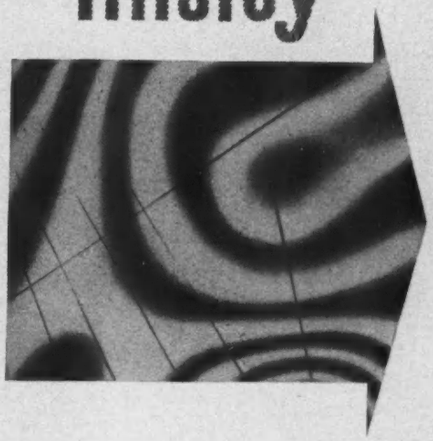

strain gauges

The electrical resistance strain gauge consists of a grid of fine wire bonded to a paper or Araldite membrane which can be cemented to the surface under investigation. Connections are taken from the gauge to apparatus designed to give reliable and quick readings of the strain being measured.

Tinsley strain gauges are available in various designs and materials to meet individual requirements within three broad temperature ranges:—

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Medium temp. gauges	.. ..	**300° C Max.**
High temp. gauges ..	.. ..	**700° C Max.**

A range of measuring instruments can be supplied for indicating and recording static strains.

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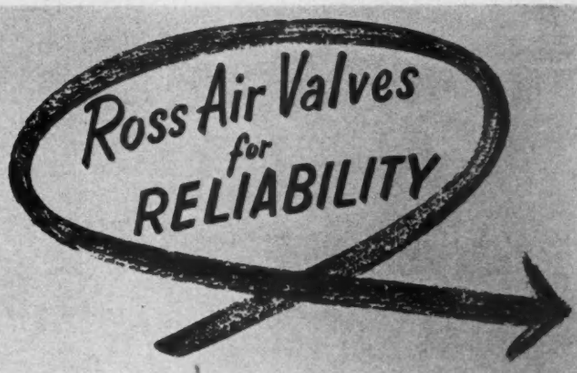

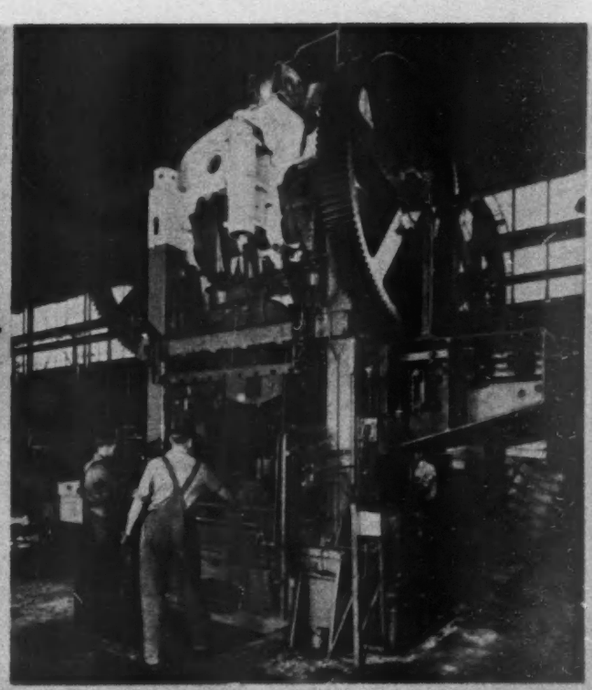

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BY PNEUMATICS, MEANS

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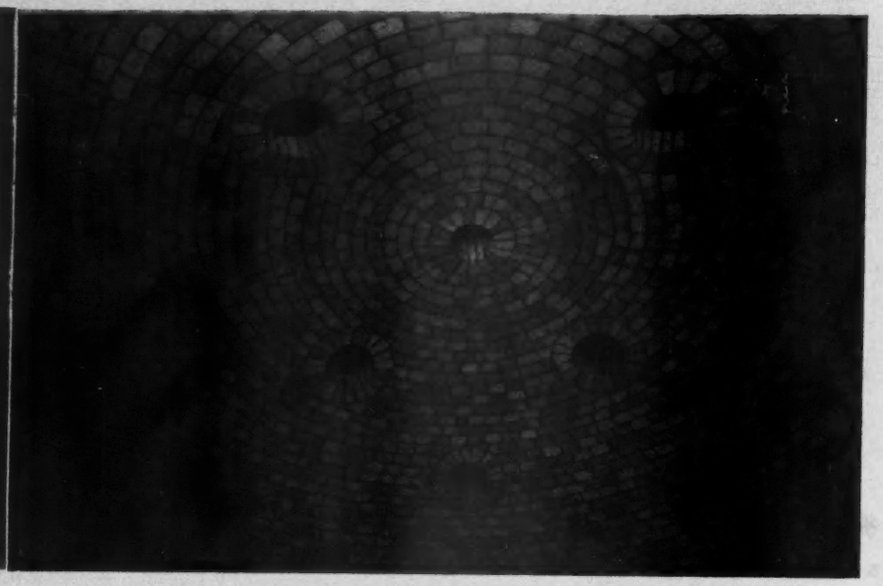

Five years ago we began rebuilding the round down-draught kilns of the Morgan Crucible Co. Ltd. at Battersea in MI.28–a hot-face insulating brick of low thermal capacity that was then comparatively new. The roof of one of these furnaces immediately after installation is shown in the first picture.

. . . (MI. 28 bricks) . . . and like it

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MORGAN Refractories Ltd

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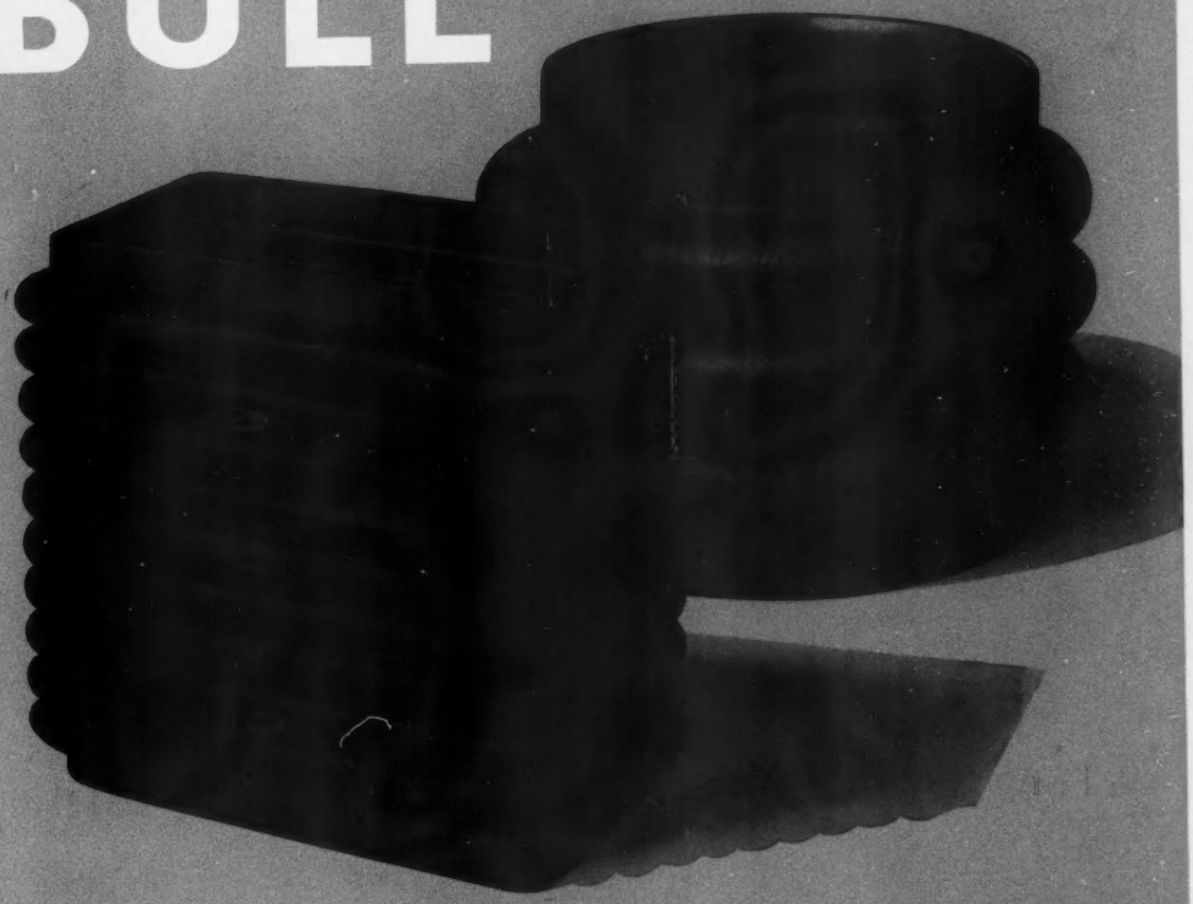

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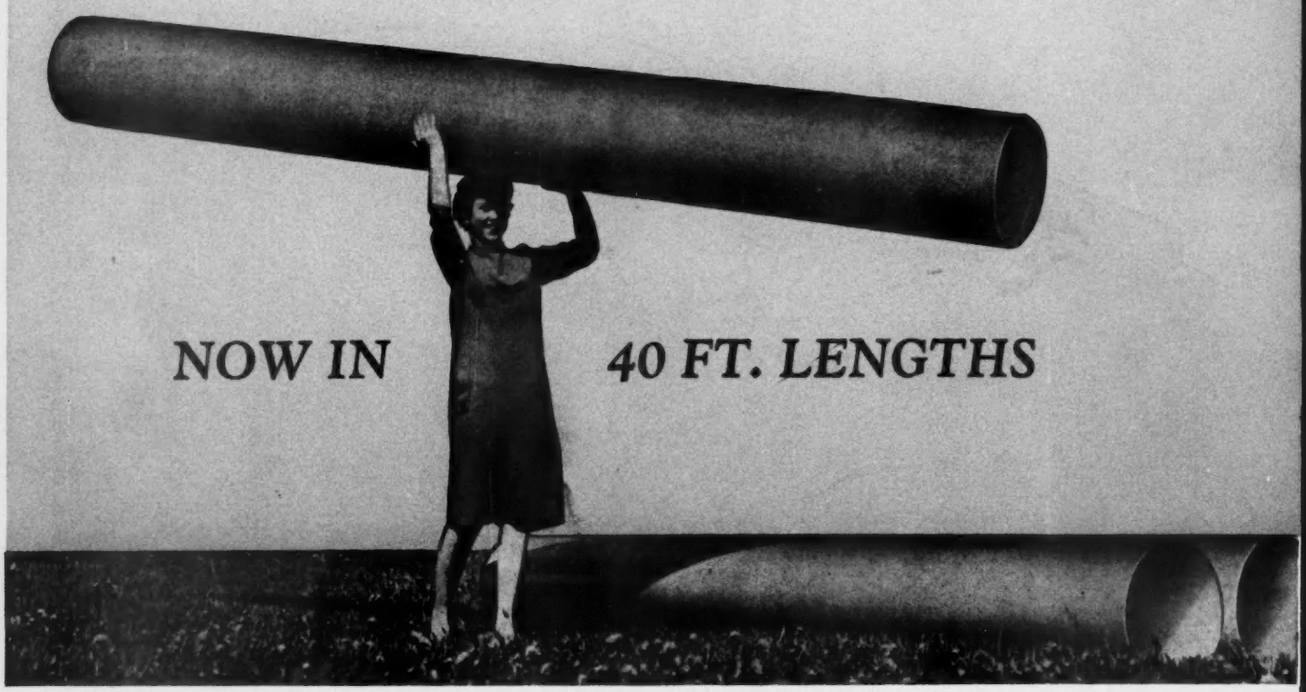

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GLASS-FIBRE-REINFORCED POLYESTER RESIN

Flexo tubes and pipes, made from glass-fibre-reinforced polyester resin, are recommended for conveying mild acids and alkalis and corrosive dust. They have a high strength/weight ratio—the wall thickness being variable from 1/64″ to 3/16″ to suit the bore and the application. Flexo tubes and pipes are available in a variety of distinguishing colours from 1½″ to 20″ bore.

Technical details from the sole manufacturers

FLEXO PLASTIC INDUSTRIES LTD

(A member of the Cork Manufacturing Company Group)

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